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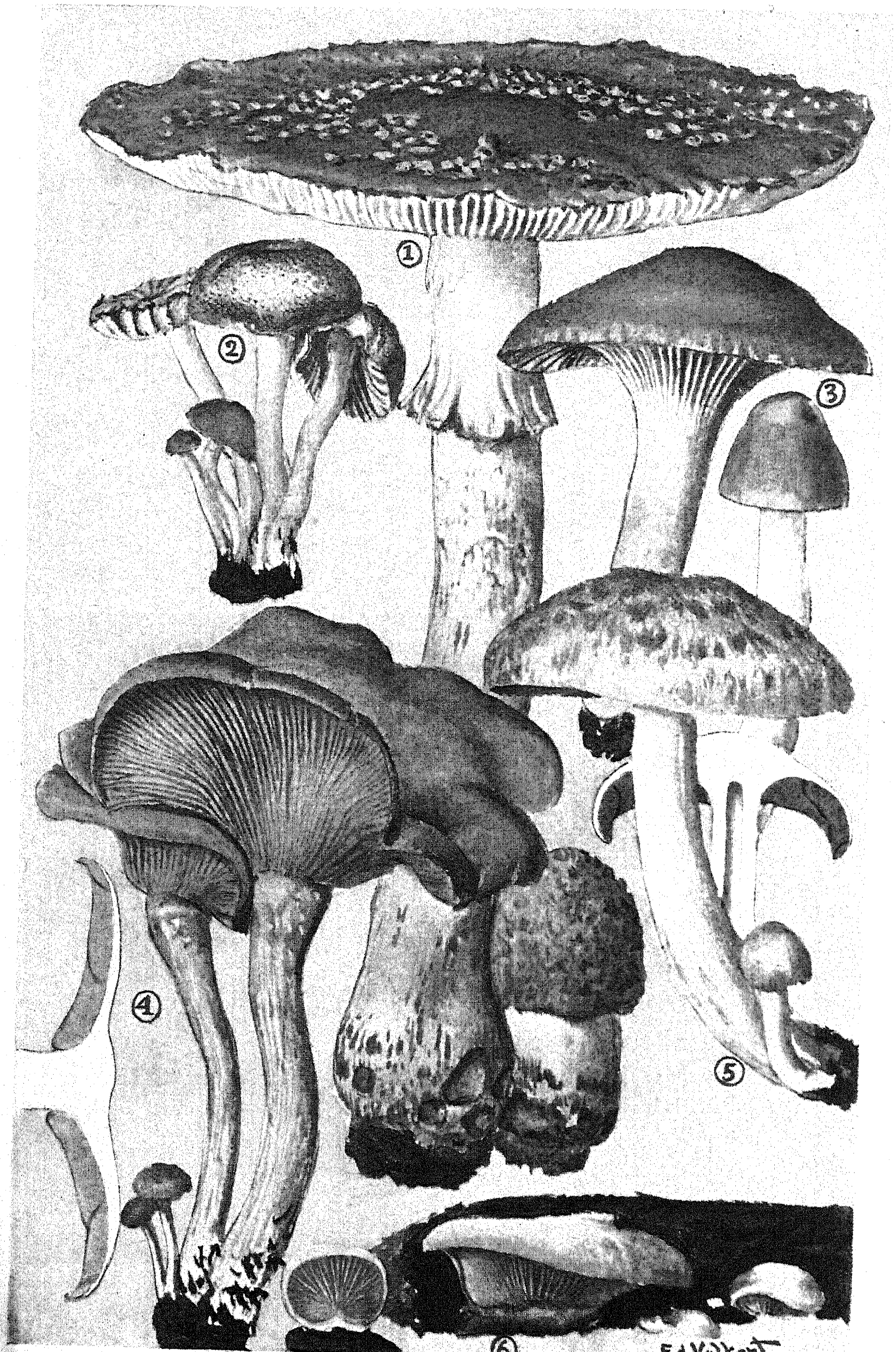


ILLUSTRATIONS OF FUNGI

MYCOLOGIA

VOL. VI JANUARY, 1914 No. 1

ILLUSTRATIONS OF FUNGI—XVII

WILLIAM A. MURRILL

The species here figured are mostly rare in the vicinity of New York and of little importance to the mycophagist.

Venenarius rubens (Scop.) Murrill

Amanita rubescens Pers.

BLUSHING VENENARIUS

Plate 113. Figure 1. × 1

Pileus ovoid to convex, at length expanded, 6–12 cm. broad, surface adorned with numerous thin, floccose or farinose warts, variable in color, always tinged with reddish or brownish-red, changing slowly to reddish when bruised, margin smooth or faintly striate; context white, changing slowly to reddish when bruised, with a pleasant odor and taste; lamellae free or slightly adnexed, crowded, nearly plane, white, characteristically chalky-white when dry; spores ellipsoid, smooth, hyaline, 10–11 × 6–7 μ; stipe equal or slightly tapering upward, usually bulbous, squamulose, whitish suffused with red, becoming reddish when bruised, stuffed, 6–20 cm. long, 6–12 mm. thick; annulus superior, ample, white, easily torn; volva very fragile, most of the fragments appearing on the surface of the pileus, while a few remain clinging to the margin of the bulb.

Found commonly in woods and groves from Maine to Alabama and west to Ohio. It contains poisons when raw, but these are disorganized by cooking or digestion. Although edible, I cannot advise any one to eat it, since many of its near relatives are so

[MYCOLOGIA for November, 1913 (5: 287–329), was issued Nov. 25, 1913].

deadly. It might easily be confused with *Venenarius muscarius*, for example.

Hydrocybe caespitosa sp. nov.

CLUSTERED HYDROCYBE

Plate 113. Figure 2. × 1

Pileus convex to obconic, depressed at the center, loosely or densely clustered, about 2–2.5 cm. broad and 1.5 cm. thick; surface dry, melleous, ornamented with brown, innate, pointed scales, which are denser on the disk; context flavous, mild; lamellae broad, ventricose, distant, sinuate-decurrent, stramineous to cremeous; spores ellipsoid, pointed at one end, smooth, hyaline granular, $7.5–8.5 \times 4–5\,\mu$; stipe equal or enlarged above, glabrous, shining, citrinous, spongy within, 4–5 cm. long, 3–5 mm. thick.

Type collected among moss in an open pasture east of Bronx Park, New York City, September 26, 1909, by W. A. Murrill. Also collected in the same field October 8, 1911, by W. A. Murrill and E. C. Volkert. Specimens have been sent me very recently by Professor Coker from Chapel Hill, North Carolina, collected by W. B. Cobb. According to Saccardo's nomenclature, this species would be called **Hygrophorus caespitosus.**

Hydrocybe pratensis (Pers.)

Hygrophorus pratensis (Pers.) Fries

MEADOW HYDROCYBE

Plate 113. Figure 3. × 1

Pileus conic to convex, at length expanded, usually umbonate, 3–6 cm. broad; surface dry, smooth, glabrous, pale-testaceous, testaceous on the umbo, very slightly striate on the margin; context subconcolorous, mild; lamellae adnate to long-decurrent, subdistant, interveined, rather narrow and arcuate, ochroleucous with a pale-rosy tint; spores ellipsoid, smooth, hyaline, about $7 \times 5\,\mu$; stipe equal or slightly enlarged above, glabrous, white at the apex, white or slightly ochraceous below, hollow, reaching 5 cm. long and 1 cm. thick.

The above description was drawn from specimens collected in woods near Bronx Park, October, 1911. The species is widely distributed in woods and pastures and has many forms, one of which was figured in MYCOLOGIA for July, 1910.

Melanoleuca sordida (Schum.) Murrill

Tricholoma sordidum (Schum.) Fries

SORDID MELANOLEUCA

Plate 113. Figure 4. × 1

Pileus thin, convex to plane or slightly depressed, subumbonate at times, often irregular, gregarious or cespitose, 3–7 cm. broad; surface smooth, glabrous, pale-violet to avellaneous with ochraceous hues, usually fuliginous on the disk, margin naked, involute when young; context violaceous to whitish, mild, edible; lamellae sinuate to slightly decurrent, narrow, crowded, concolorous when young, fading with age; spores ellipsoid, smooth, pale-rosy-ochraceous in mass, $7–8 \times 4–5\,\mu$; stipe eccentric at times, equal, firm, concolorous, glabrous, stuffed or hollow, 3–8 cm. long, 4–8 mm. thick.

This species is rarely reported, but apparently is widely distributed though not abundant, occurring about manure piles and in cultivated ground where considerable manure is used. I have found it at two different places in the Garden and in great abundance under weeds on an old pile of cow manure just east of the Garden. It is much like *Melanoleuca personata*, with similar violet tints and spores colored exactly alike, but the cap is thinner and differently colored, the gills duller and browner, and the stem much slenderer and never bulbous. It also differs in its habitat and more or less clustered habit. American plants called *Tricholoma nudum* by some mycologists are doubtless referable to this species. *T. nudum* seems to be confused with *T. personatum* in some parts of Europe. René Maire has recently erected a new genus *Rhodopaxillus*, for species of *Tricholoma* having pale-rosy-ochraceous spores.

Hypholoma aggregatum Peck

CLUSTERED HYPHOLOMA

Plate 113. Figure 5. × 1

Pileus thin, convex, densely cespitose, reaching 5 cm. broad; surface dry, white or grayish, ornamented with a few appressed, pale-umbrinous or avellaneous, fibrillose scales; context soft, watery, thin, odorless, mild; lamellae adnate or sinuate, rather crowded, whitish at first, at length dark-brown with a whitish edge; spores ellipsoid, smooth, brown, $7 \times 4\,\mu$; stipe long, equal, fibrillose, striate at the apex, hollow, reaching 6 cm. long and 1 cm. thick.

This is a rare species, found in rich soil in woods, and described from Alcove, New York, in 1893. It has been collected in the Garden once, and again in woods east of Bronx Park. *H. silvestre* is closely related.

Claudopus nidulans (Pers.) Peck

NEST-MAKING CLAUDOPUS

Plate 113. Figure 6. × 1

Pileus sessile or narrowed to a very short stipe, reniform to circular, usually imbricate, reaching 5 cm. or more broad; surface dry, tomentose or somewhat hirsute, bright-yellow, margin involute; context slightly tough; spores smooth, pink in mass, 6–7 μ long.

This beautiful species is widely distributed, occurring on dead logs in woods during autumn. It is the most important representative of the small genus *Claudopus,* which differs from *Pleurotus* in having rosy instead of white spores. The plants figured are small ones.

NEW YORK BOTANICAL GARDEN.

A PRELIMINARY STUDY OF THE GENUS LAMPROSPORA

Fred J. Seaver

(With Plate 114, Containing 13 Figures)

In a previous paper,[1] the writer has called attention to some of the difficulties in the study of the present genus and in the same paper described two new species. The accumulation of additional data regarding the various species of the genus together with the collection of several apparently undescribed species has led the writer to make a preliminary study of the genus in North America. One of the most conspicuous features of many of the plants of the genus is their small size, many of them being one millimeter or less in diameter. For this reason many of the species have apparently been overlooked and even the best known are not often collected. While the ground has been covered as thoroughly as possible at the present time, it is not likely that the following list contains nearly all of the species occurring in North America.

About half of the species of the genus have sculptured spores and the nature of the sculpturing in such species furnishes one of the most valuable diagnostic characters. In many of the old descriptions the spores were simply described as rough or smooth with no definite information as to the exact nature of these roughenings. In the present paper especial attention has been given to a study of these spore characters. In most cases these studies have been based on fresh material collected by the writer. In a few cases we have been compelled to rely on dried specimens. An attempt has been made to bring out these characters in the accompanying plate.

The genus as treated here is used in rather a broader sense than the genus *Barlaea* of Saccardo, being made to include the genus *Detonia*, which, so far as I am able to judge, differs only in

[1] Mycologia 4: 45–48. 1912.

the larger size of the plants. The chief object of the present paper is to call attention to the number and variety of the species of the genus with the hope that these plants may receive more attention from collectors than they have formerly.

LAMPROSPORA De-Not. Comm. Critt. Ital. 1: 388. 1864

Crouania Fuckel, Symb. Myc. 320. 1869. Not *Crouania* Agardh. 1842.

Plicaria Fuckel, Symb. Myc. 325. 1869.

Barlaea Sacc. Syll. Fung. 8: 111. 1889. Not *Barlaea* Reich. 1877.

Detonia Sacc. Syll. Fung. 8: 105. 1889.

Plicariella (Sacc.) Lindau in E. & P. Nat. Pfl. 1^1: 179. 1897.

Barlaeina Sacc. Syll. Fung. 14: 30. 1899.

Pulvinula Boud. Hist. Class. Discom. 69. 1907.

Plants small or medium sized (.5 mm. to 3 cm. in diameter), concave, plane or slightly convex, sessile, usually bright colored, some shade of red, orange or yellow, more rarely pallid or dark colored, purple or brownish-black, externally smooth or verrucose but never clothed with well-developed hairs, substance fleshy, hymenium often roughened with the protruding asci; asci 8-spored, operculate; spores comparatively large, at first globose or subglobose, and smooth, at maturity often sculptured (spinulose, verrucose, reticulate, tuberculate or annulate), or remaining permanently smooth, hyaline or more rarely faintly colored yellowish or smoky-brown; paraphyses filiform or clavate, straight or curved.

Type species, *Ascobolus miniatus* Crouan.

KEY TO THE SPECIES

Plants small, not exceeding 5 mm. in diameter (usually 1 or 2 mm.).
- Spores rough (reticulate, spinulose, verrucose, tuberculate, or annulate).
  - Spores marked with ridges.
    - Ridges giving rise to reticulations (net-like markings over the surface).
      - Reticulations shallow, barely roughening the surface of the spore.
        - Spores at maturity 20–22 μ in diameter, ridges of reticulations about 1 μ thick. 1. *L. Crouani.*

Spores at maturity 12–15 μ in diameter, reticulations very delicate, scarcely more than lines over the surface of the spore. 2. *L. dictydiola.*
Reticulations deep, extending 2 μ or more beyond the periphery of the spore and appearing as a broad band about its surface. 3. *L. areolata.*
Ridges not giving rise to reticulations.
Ridges usually curved and extending in various directions as in some species of *Ascobolus.* 4. *L. ascoboloides.*
Ridges giving rise to two distinct rings about the spore. 5. *L. annulata.*
Spores not marked with ridges.
Spores covered with spines.
Plants not exceeding 1 mm. in diameter, spines short, blunt. 6. *L. spinulosa.*
Plants at maturity 3–5 mm. in diameter, spines long and very sharp. 7. *L. Crec'hqueraultii.*
Spores covered with warts or tubercles.
Tubercles large, twelve or rarely fourteen or fifteen about the circumference of the spore.
Individual tubercles not rough. 8. *L. tuberculata.*
Individual tubercles covered with minute roughenings, giving them a translucent appearance. 9. *L. Maireana.*
Tubercles small, about twenty or more in the circumference of the spore.
Spores subglobose, on bark among moss. 10. *L. Wrightii.*
Spores perfectly globose, on soil.
Plants pale orange. 11. *L. tuberculatella.*
Plants violaceous. 12. *L. amethystina.*
Spores smooth.
Plants pale orange.
About 3 mm. in diameter at maturity, crowded, on burnt ground. 13. *L. carbonaria.*
About 1 mm. or less in diameter, scattered, on damp soil. 14. *L. haemastigma.*
Plants bright red.
Several mm. in diameter, spores 15–18 μ in diameter, on damp soil. 15. *L. Constellatio.*
Less than 1 mm. in diameter, spores 8–9 μ in diameter, on foliage of *Sequoia.* 16. *L. gemma.*
Plants pallid or creamy. 17. *L. discoidea.*

Plants large, usually 5 mm. or more in diameter.
Plants dark colored, purple or brown to blackish.
Brown or blackish, occurring on burnt ground.
Spores rough.
Plants externally rough, spores about 18 μ in diameter. 18. *L. trachycarpa.*
Plants externally smooth, spores about 9 μ in diameter. 19. *L. nigrans.*
Spores smooth. 20. *L. leijocarpa.*
Plants dark purple. 21. *L. Planchonis.*
Plants bright colored, orange.
Spores rough. 22. *L. lobata.*
Spores smooth. 23. *L. polytrichina.*

1. **Lamprospora Crouani** (Cooke)

Ascobolus miniatus Crouan, Ann. Sci. Nat. IV. **10**: 197. 1858.
Not *A. miniatus* Preuss, Linnaea **24**: 147. 1851.
Ascobolus Crouani Cooke, Jour. Bot. **2**: 151. 1864.
Peziza Crouani Cooke, Grevillea **3**: 31. 1874.
Crouania miniata Fuckel, Symb. Myc. 320. 1869.
Lamprospora miniata De-Not. Comm. Critt. Ital. **1**: 388. 1864.
Aleuria Crouani Gill. Champ. Fr. Discom. 50. 1878.
Barlaea miniata Sacc. Syll. Fung. **8**: 111. 1889.

Plants gregarious, or crowded, at first subglobose, expanding and becoming plane or with the hymenium a little concave with a slightly elevated and often fringe-like margin, bright red, without and within, margin lighter, almost white, 1–5 mm. in diameter (usually about 3 mm. at maturity); asci cylindric or subcylindric, about 20–22 μ in diameter; spores 1-seriate, at first smooth and usually containing one large oil-drop, at maturity becoming delicovering the entire surface of the spore, meshes of the reticulacately roughened, roughenings taking the form of reticulations tions 2–4 μ, rarely 5 or 6 μ in diameter, ranging from 3–6-sided, with the sides usually of unequal length but occasionally giving rise to almost perfect hexagonal figures, ridges very even and delicate, less than 1 μ broad, the ridges giving rise to a perfect unbroken net-work about the spore and very shallow as indicated by the roughenings about the periphery of the spore, entire spore 15–22 μ in diameter (usually about 20–22 μ at maturity), hyaline; paraphyses thickened above and filled with orange granules.

On damp soil usually among moss plants.

TYPE LOCALITY: Brest, France.

DISTRIBUTION: New York to Colorado; also in Europe.

ILLUSTRATIONS: Ann. Sci. Nat. IV. **10**: *pl. 13, f. 44–47;* Cooke, Mycogr. *pl. 5, f. 17;* Gill. Champ. Fr. Discom. *pl. 52, f. 2.*

Crouan's type has not been seen but authentic specimens from M. C. Cooke's collection have been examined and found to agree with American specimens referred to this species. One collection in great abundance was made near New York City during the past season.

2. LAMPROSPORA DICTYDIOLA Boud. Hist. Class. Discom. 68. 1907

Plants gregarious or scattered, not crowded, expanding with the hymenium, becoming plane or nearly so and bordered with a delicate, ragged, fringe-like margin and more or less pitted and roughened, entirely orange without and within, about 1 mm. in diameter (in the living specimens examined); asci cylindric or subcylindric, about 18–20 μ in diameter and of variable length; spores 1-seriate, at first smooth and usually with one large oil-drop, at maturity becoming very delicately reticulate, meshes of the reticulations 1 μ or less in diameter and ridges appearing as single lines (when examined with a one sixth objective); entire spore 12–15 μ in diameter, hyaline; paraphyses enlarged above reaching a diameter of 5 μ, nearly straight or occasionally a little curved, never hooked as in some related species.

On charcoal which has been overgrown with mosses.

TYPE LOCALITY: Montmorency, France.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATION: Boud. Ic. Myc. *pl. 403.*

Our specimens conform well with the illustration of this species by Boudier. The species has been collected twice but in each case not over two or three plants were found.

3. LAMPROSPORA AREOLATA Seaver, Mycologia 4: 48. 1912

Plants gregarious, small, .5–1 mm. in diameter, at first globose, opening rather irregularly, at maturity with the hymenium plane or slightly convex, more or less roughened by the protruding asci, orange to bright red; asci cylindric, 15–22 μ in diameter and of variable length, tapering below into a stem-like base; spores 1-seriate, at first smooth, with usually one large oil-drop, becoming rough at maturity, roughenings taking the form of deep areolations, areolae 3–5 μ in diameter, 3–6-sided, often forming

nearly perfect hexagonal figures or with the sides of irregular length, 2–3 μ deep as indicated by the projecting ridges about the periphery of the spore, ridges thin scarcely more than 1 μ thick, entire spore including projections 18–20 μ in diameter, hyaline; paraphyses strongly thickened above.

On damp soil among mosses and algae.

TYPE LOCALITY: Yonkers, New York.

DISTRIBUTION: New York to Connecticut.

ILLUSTRATIONS: Mycologia 4: *pl. 57, f. 5–8.*

Since the publication of this species, it has been frequently collected about New York City. The largest plants seen are not over 1 mm. in diameter. The peculiar spore characters mentioned in the original description have been found to be constant in all of the specimens examined.

4. **Lamprospora ascoboloides** sp. nov.

Plants gregarious, at first globose and partially buried, gradually opening with the hymenium at first slightly concave, gradually becoming plane and at maturity convex with the margin indistinct, usually not exceeding 1 mm. in diameter and often smaller, closely nestling in little depressions in the substratum but never buried, entirely orange, externally slightly floccose, hymenium roughened by the protruding asci which are comparatively large, finally becoming pitted as a result of the collapsing of the empty asci, the hymenium often collapsing when dry becoming concave; asci cylindric-clavate, about 175–225 $\times$ 18–20 μ; spores at first smooth with one or two oil-drops gradually becoming rough, increasing in size, at maturity covered with irregular ridge-like markings; ridges straight or more often curved, several often parallel or extending in various directions and sometimes at right angles, occasionally branched, rarely a few running together giving rise to irregular and imperfect reticulations over a part of the spore but never completely or perfectly reticulate, ridges nearly 2 μ thick, markings resembling those of certain species of *Ascobolus,* 15–18 μ in diameter (usually about 17 μ at maturity), hyaline; paraphyses clavate, 5–6 μ in diameter at their apices.

Type collected on soil in Portland, Connecticut.

DISTRIBUTION: Connecticut, New York and Virginia.

The species has been frequently collected about New York City since the original collection was made in Portland, Connecticut. The species is distinguished by the peculiar *Ascobolus*-like markings of the spores.

5. **Lamprospora annulata** sp. nov.

Plants gregarious but not crowded, at first globose and partially immersed in the substratum becoming expanded and with the hymenium plane or nearly plane and more or less pitted and roughened, pale orange, .5 mm. to nearly 1 mm. in diameter; asci cylindric or subcylindric, rather abruptly attenuated below into a short much contorted pedicel, entire ascus about 200 μ long and about 20 μ in diameter, at first almost filled with the spores, in older asci the lower part stretching and becoming about equal in length to the spore-bearing portion; spores 1-seriate from the first, perfectly globose and smooth when young and containing a few small oil-drops and granules, 12–14 μ in diameter, with two small rings appearing at an early stage about the proximal and distal sides of the spore giving rise to four small circles where the rings pass about the periphery of the spore, rings increasing in size until they reach a thickness of about 3 μ, the surface of the spore becoming minutely verrucose with age, the rings at maturity giving the spore a short cylindric appearance with the axis of the cylinder parallel with the ascus, entire spore when mature about 16–18 μ in diameter, rings of about the same diameter and nicely fitted over the opposite sides of the spore, the two rings usually parallel but occasionally one of them shifted out of its normal position, hyaline; paraphyses thickened above and densely filled with large granules, about 5 μ in diameter at the widest point.

On soil among moss and algae.

TYPE LOCALITY: Portland, Connecticut.

DISTRIBUTION: New York and Connecticut.

In addition to the type of this species which was collected in Portland, Connecticut, August, 1913, one collection was later made near New York City. This last collection consisted of three plants each less than one millimeter in diameter. The spore characters were identical with those of the Connecticut specimen.

6. **Lamprospora spinulosa** sp. nov.

Plants gregarious, minute, usually not exceeding 1 mm. in diameter and often less, at first closed and nearly globose, gradually expanding at maturity with the hymenium slightly convex and surrounded by an irregular fringe-like margin, externally slightly floccose, hymenium roughened by the asci which protrude

often half their length above the paraphyses, collapsing after discharging their spores; asci clavate-cylindric, about 200 $\times$ 18–20 μ; spores at first smooth with one large oil-drop, becoming delicately roughened, at maturity with short stout spines, about 1 μ in diameter and 2–3 μ in length, becoming adpressed when dry, entire spore about 15–20 μ in diameter (including spines), hyaline; paraphyses clavate, septate and granular within.

On soil among moss. New York Botanical Garden, 1912.

This plant which is 1 mm. or less in diameter has often been collected about New York City. The spores as well as the external characters of the species are very different from *L. Crec'hqueraultii* another spinulose-spored species. I find no description of the species.

7. LAMPROSPORA CREC'HQUERAULTII (Crouan) Boud. Ic. Myc. expl. pl. 11. 1909

Ascobolus Crec'hqueraultii Crouan, Ann. Sci. Nat. IV. **10**: 194. 1858.

Peziza modesta Karst. Act. Fauna Fl. Fenn. **10**: 122. 1869.

Peziza echinosperma Peck, Ann. Rep. N. Y. State Mus. **24**: 95. 1872.

Peziza auriflava Cooke, Mycogr. 16. 1875.

Aleuria auriflava Gill. Champ. Fr. Discom. 50. 1879.

Mollisia Crec'hqueraultii Gill. Champ. Fr. Discom. 118. 1882.

Crouania asperella Rehm, Hedwigia **24**: 226. 1885.

Humaria Crec'hqueraultii Quél. Enchir. 288. 1886.

Barlaea Crec'hqueraultii Sacc. Syll. Fung. **8**: 113. 1889.

Barlaea asperella Sacc. Syll. Fung. **8**: 113. 1889.

Barlaea modesta Sacc. Syll. Fung. **8**: 113. 1889.

Humaria echinosperma Sacc. Syll. Fung. **8**: 130. 1889.

Plicariella modesta Lindau in E. & P. Nat. Pfl. **1**^{2}: 180. 1897.

Plants gregarious, 2–5 mm. in diameter (usually 2 or 3), entirely smooth without and within, hymenium at first slightly concave becoming plane or more often convex, margin indistinct in mature plants and entire plant often becoming irregular in form, very pale orange externally and internally, fading to dirty yellowish-white in dried specimens; asci cylindric, or subcylindric, about 300–325 $\times$ 27 μ protruding above the hymenium; spores 1-seriate, at first smooth, at maturity spinulose, globose, or rarely

very slightly elongated, spines conspicuous, irregular in length, broad at the base and tapering to a very sharp point at the apex, often 2 or 3 μ long, in dried specimens becoming bent and adpressed to the sides of the spore but regaining their normal form when wet, entire spore 18–22 μ in diameter (including spines), hyaline; paraphyses thickened at their apices.

On clayey soil.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Delaware, West Virginia and Colorado; also in Europe.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. **24**: *pl. 3, f. 10–13;* Ann. Sci. Nat. IV. **10**: *pl. 13, f. 12–15;* Boud. Ic. Myc. *pl. 404, 405;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 12, f. 4;* Cooke, Mycogr. *pl. 6, f. 22, 23.*

EXSICCATI: Ellis, N. Am. Fungi *840* (as *Peziza echinosperma* Peck); Ellis, N. Am. Fungi *841* (as *Peziza modesta* Karst.); Clements, Crypt. Form. Colo. *115* (as *Detonia modesta*).

In addition to the synonyms previously published, the writer has examined cotype specimen of *Peziza echinosperma* Peck and finds it to be identical with the above.

8. LAMPROSPORA TUBERCULATA Seaver, Mycologia **4**: 47. 1912

Plants gregarious in small clusters, not crowded but rarely with two or three in close contact, at first globose and almost buried in the sandy soil on which they grow, when young tapering above or subconic in form, with the hymenium gradually expanding and at maturity plane or nearly so, often with a fringe-like border and roughened by the protruding asci which appear above as minute white spines, superficial but with the base still nestling in the substratum, about .5 mm. in diameter or rarely attaining a diameter of nearly 1 mm.; asci cylindric or subcylindric, slightly narrowed near the apex, and tapering below into a stem-like base, 25–28 μ in diameter and about 275–300 μ long; spores 1-seriate, at first smooth and usually with one large oil-drop, gradually becoming rough, at maturity very coarsely tuberculate, tubercles covering the surface of the spore and appearing about its margin like great lumps often projecting further in one place than another giving the spore an irregular outline, individual tubercles about 3–4 μ in diameter, giving rise to 12 or rarely 14 or 15 lobes about the periphery of the spore, entire spore 18–20 μ in diameter at maturity, hyaline; paraphyses en-

larged above attaining a diameter of 6 μ, filled with orange granules.

On soil in open places among mosses and algae.

TYPE LOCALITY: Woods near Yonkers, New York.

DISTRIBUTION: New York to Virginia.

ILLUSTRATIONS: Mycologia 4: *pl. 57, f. 1–4.*

Numerous collections of this species have been made about New York City during the past season. The coarse tuberculate marking of the spores is a constant feature in all of the specimens examined.

9. **Lamprospora Maireana** sp. nov.

Plants gregarious, at first globose, becoming expanded, at maturity with the hymenium plane or slightly concave, entirely pale orange without and within, reaching a diameter of about 2 mm.; asci cylindric or subcylindric, gradually tapering below into a stem-like base, having a diameter of 30 μ at the broadest point and reaching a length of 300–325 μ; spores 1-seriate, perfectly globose, at first smooth, at maturity becoming roughened, roughenings taking the form of tubercles which are as large as 3–5 μ in diameter and appearing as scallops about the periphery of the spore, the tubercles bearing secondary roughenings which give to each a minutely roughened surface, and giving the whole spore a translucent effect, entire spore at maturity, about 23 μ in diameter, subhyaline; paraphyses strongly thickened at their apices, reaching a thickness of 8 μ.

On the ground among moss and algae.

TYPE LOCALITY: Algiers, North Africa.

DISTRIBUTION: New York; also in North Africa.

EXSICCATI: Maire, Myc. Bor. Africana *22* (as *L. tuberculata* Seaver).

This species was distributed by R. Maire as *L. tuberculata.* Close comparison however shows the two to be quite different. The plants are larger, the spores larger and the sculpturing of the spores quite different. The warts in the African species are not so prominent as in *L. tuberculata* and the secondary roughening of the tubercles does not occur in *L. tuberculata.* A single local collection has been made by the writer in which the spores agree with the specimen collected by Maire so that the species probably occurs in North America.

10. **Lamprospora Wrightii** (Berk. & Curt.)

Peziza Wrightii Berk. & Curt. Ann. Mag. Nat. Hist. III. **15**: 444. 1865.

Barlaea Wrightii Sacc. Syll. Fung. **8**: 112. 1889.

Humaria Wrightii Boud. Hist. Class. Discom. 68. 1907.

Plants gregarious or scattered, at first globose, becoming expanded with the hymenium plane or slightly concave, surrounded by a delicate irregular elevated margin giving it a fringe-like border, entirely pale orange, slightly paler externally and minutely roughened; asci cylindric or slightly clavate; spores usually 1-seriate or irregularly crowded, globose or more often just slightly ellipsoid, at first smooth, with one or sometimes several oil-drops, becoming roughened at maturity, roughenings taking the form of small wart-like bodies, which are usually rather widely scattered over the surface of the spore, 15–17 μ in diameter, hyaline; paraphyses strongly enlarged above, filled with granules.

On bark of trees among moss.

TYPE LOCALITY: Bodelwyddan, Flintshire, Wales.

DISTRIBUTION: Alabama, Texas and Cuba; also in Europe.

ILLUSTRATIONS: Ann. Mag. Nat. Hist. III. **15**: *pl. 15, f. 16;* Boud. Ic. Myc. *pl. 399;* Cooke, Mycogr. *pl. 5, f. 18.*

The spores were originally described as echinulate but this may have been due to faulty observation since later students of the type describe the spores as verrucose. An Alabama specimen examined agrees perfectly with Boudier's illustration of this species.

11. **Lamprospora tuberculatella** sp. nov.

Plants gregarious but never crowded, often five or six plants in the space of 1 cm., at first globose, opening at the top and gradually expanding, at maturity discoid, convex above and floccose with the asci which protrude above the hymenium half their length appearing as many minute white spines, whole plant pale orange, .3–.5 mm. in diameter or rarely reaching a diameter of 1 mm.; asci cylindric or subcylindric; spores 1-seriate, at first smooth and with one large oil-drop near the center, increasing in size as they mature, at maturity about 20 μ in diameter and covered with small tubercle-like markings, tubercles covering the surface of the spore and appearing beyond the periphery of the

spore like those of *L. tuberculata* but much smaller, about twenty to twenty-five around the circumference of the spore, hyaline; paraphyses enlarged above and filled with orange granules.

On soil among moss near Yonkers, New York.

This species has been frequently collected and much attention has been given to a study of the spore characters. As might at first be thought, the small wart-like markings have never been found to intergrade with those of *L. tuberculata* in which they are twice as large.

12. **Lamprospora amethystina** (Quél.)

Humaria Personii amethystina Quel. Fr. Acad. Sci. **14**: 451. 1885.

Barlaea amethystina Sacc. Syll. Fung. **8**: 116. 1889.

Plants gregarious, purplish, without and within, with a delicate white border, hymenium a little concave, reaching a diameter of 2 mm.; asci cylindric or subcylindric; spores 1-seriate, at first smooth, becoming rough at maturity, spore markings similar to those of *L. tuberculatella*, hyaline; paraphyses a little enlarged at their apices.

On the ground among moss.

TYPE LOCALITY: Jura, France.

DISTRIBUTION: Iowa; also in Europe.

ILLUSTRATIONS: Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 12, f. 3.*

The only specimens of this species seen were those collected by the writer in Iowa. The species is distinguished by its color.

13. **Lamprospora carbonaria** (Fuckel)

Crouania carbonaria Fuckel, Symb. Myc. (Nachtrag) 64. 1871.

Peziza sanguinaria Cooke, Grevillea **3**: 31. 1874.

Barlaea carbonaria Sacc. Syll. Fung. **8**: 112. 1889.

?*Lamprospora carbonicola* Boud. Hist. Class. Discom. 68. 1907.

Plants gregarious or crowded, 1–3 mm. in diameter, globose, becoming expanded with the hymenium plane or slightly concave and margin even or wavy, plants often irregular in form from mutual pressure, entirely pale orange, hymenium nearly even or

slightly floccose; asci cylindric-clavate, about $225 \times 18\text{–}20\,\mu$; spores perfectly globose and smooth with one oil-drop varying in size but often almost filling the spore, entire spore $15\text{–}18\,\mu$ in diameter, hyaline; paraphyses filiform or slightly enlarged at their apices, extending high above the asci and curved or hooked, about $3\text{–}4\,\mu$ in diameter at their apices.

On soil among moss plants in a place which has been recently burned but subsequently partially overgrown with moss.

TYPE LOCALITY: Oestrich and Budenheim woods, Germany.

DISTRIBUTION: New York; also in Europe.

Through the courtesy of Dr. Farlow, I have been permitted to examine spores of cotype material of this species. Specimens collected in the New York Botanical Garden agree with Fuckel's plants so far as we can judge from dried specimens. The species has been seen by the writer only once but occurred in good quantity.

14. **Lamprospora haemastigma** (Hedw.) ?

Octospora haemastigma Hedw. Laub-Moose **2**: 17. 1788.

Pulvinula haemastigma Boud. Hist. Class. Discom. 70. 1907.

Plants rather thickly gregarious, rarely two or three in close contact, at first globose, becoming expanded with the hymenium plane or slightly concave, entirely pale yellow (becoming brighter in dried specimens), about 1 mm. in diameter; asci cylindric or subcylindric, $20\text{–}23\,\mu$ in diameter and as long as $300\,\mu$; tapering below into a stem-like base; spores 1-seriate, smooth, usually with one large oil-drop, about $20\,\mu$ in diameter, hyaline; paraphyses very slender, strongly curved at their apices and scarcely thickened above, about $2\,\mu$ in diameter at the thickest point, densely filled with yellow granules.

On damp soil among moss.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Hedw. Laub-Moose **2**: *pl. 5, f. 1–5;* Boud. Ic. Myc. *pl. 406.*

Our plants agree well with Boudier's illustrations of what he takes to be Hedwig's species. It also agrees fairly well with Hedwig's illustration although the plants are somewhat paler. The species differs from *L. Constellatio* by the smaller size of the plants and much paler color.

15. **Lamprospora Constellatio** (Berk. & Br.)

Peziza Constellatio Berk. & Br. Ann. Mag. Nat. Hist. IV. **17**: 142. 1876.

Leucoloma Constellatio Rehm, Ber. Naturh. Ver. Augsburg **26**: 5. 1881.

Pulvinula Constellatio Boud. Bull. Soc. Myc. Fr. **1**: 107. 1885.

Aleuria Constellatio Gill. Champ. Fr. Discom. 207. (1888?)

Barlaeina Constellatio Morgan, Jour. Myc. **8**: 188. 1902.

Plants gregarious or scattered, at first globose, becoming expanded and plane or slightly concave, 1–5 mm. in diameter, hymenium bright red, color becoming brighter in dried specimens, often almost scarlet, externally lighter; asci cylindric or subcylindric, about $250–300 \times 20\,\mu$; with a long stem-like base; spores smooth with one large oil-drop often surrounded by numerous smaller ones, hyaline, $15–20\,\mu$ (usually about 18) in diameter, hyaline; paraphyses filiform, only slightly thickened at the ends and very much hooked and curved, entirely filled with red granules and sparingly septate.

On bare ground in rich soil.

TYPE LOCALITY: Addington, Kent, Great Britain.

DISTRIBUTION: New Jersey to Ontario, Colorado and Jamaica; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 407;* Cooke, Mycogr. *pl. 21, f. 81.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *2036.*

I have not seen the type of this species but American specimens conform well with European illustrations and exsiccati. The species was frequently collected by the writer in the Rocky Mountains and has been less frequently collected in the East.

16. **Lamprospora gemma** (Phill.)

Peziza gemma Phill. Grevillea **7**: 21. 1878.

Barlaea gemma Sacc. Syll. Fung. **8**: 112. 1889.

Plants gregarious, sessile, fleshy, subturbinate, finally expanded with the hymenium plane or slightly concave, asci cylindric; spores 1-seriate, globose, smooth, hyaline, about $8\,\mu$ in diameter; paraphyses filiform, very slender and branched, straight or more or less curved at their apices.

On decaying foliage of *Sequoia sempervirens.*

TYPE LOCALITY: California.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATION: Cooke, Mycogr. *pl. 111, f. 398.*

A specimen of this species collected by Harkness in California has been examined. The species differs from *L. Constellatio* in the much smaller size of the spores. The plants are also much smaller.

17. **Lamprospora discoidea** (P. Henn. & E. Nym.)

Barlaea discoidea P. Henn. & E. Nym. Monsunia **1**: 33. 1900.
Barlaeina discoidea Sacc. Syll. Fung. **16**: 710. 1902.

Plants scattered or gregarious, sessile, at first subglobose, expanding leaving the margin elevated and hymenium slightly concave, but soon becoming plane and later strongly convex, minutely roughened by the protruding asci, entire plant reaching a maximum of 2 mm. in diameter (usually 1 mm. in diameter at maturity), color white or grayish white or with a slight tinge of yellow or cream; asci subcylindric above, tapering below into a slender stem-like base which is usually forked, about 200–250 $\times$ 20 μ; spores 1-seriate, smooth, with one large oil-drop which nearly fills the spore, rather thick-walled, 15–20 μ in diameter (usually about 17 μ), hyaline; paraphyses slender, slightly enlarged upwards, about 5 μ in diameter at their apices.

On rather sandy soil or among moss.

TYPE LOCALITY: Java.

DISTRIBUTION: New York; also in Asia.

The pale color is the distinguishing character of this species, which was found to be very common in the New York Botanical Garden during the past season. It is very different in appearance from any of the other species here described.

18. **Lamprospora trachycarpa** (Curr.)

Peziza trachycarpa Curr. Trans. Linn. Soc. **24**: 493. 1864.
Peziza scabrosa Cooke, Mycogr. 170. (1879?)
Discina trachycarpa Karst. Act. Fauna Fl. Fenn. **2**: 113. 1885.
Plicaria trachycarpa Boud. Bull. Soc. Myc. Fr. **1**: 102. 1885.
Aleuria trachycarpa Gill. Champ. Fr. Discom. 207. (1888?)
Detonia trachycarpa Sacc. Syll. Fung. **8**: 105. 1889.

Phaeopezia scabrosa Sacc. Syll. Fung. 8: 472. 1889.
Plicariella trachycarpa Rehm, Rabenh. Krypt. Fl. 1^3: 996. 1896.

Plants gregarious or densely crowded, often forming continuous masses extending over many cm., at first globose, gradually opening above and becoming shallow cup-shaped with the margin incurved and elevated or more rarely closely adhering to the substratum, regular in form or cochleate and becoming very irregular especially when closely crowded, hymenium smooth or convolute, dark reddish-brown or slightly olivaceous, becoming black in dried specimens, externally lighter colored and rough, often densely verrucose, 5 mm. to 2 cm. in diameter; asci cylindric or subcylindric, about 15–18 μ in diameter and of variable length but often reaching 250–300 μ; spores 1-seriate, at first smooth, becoming rough, roughenings taking the form of small tubercles or often elongated, appearing like very short interrupted ridges, becoming pale yellowish or smoky at maturity, about 15–18 μ in diameter; paraphyses thickened above and adhering more or less together at their apices, yellowish-brown.

On burnt ground and charcoal beds.

TYPE LOCALITY: Ascot Heath, Great Britain.

DISTRIBUTION: New York to Colorado; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 300;* Bull. Lab. Nat. Hist. State Univ. Iowa 6: *pl. 14, f. 1;* Cooke, Mycogr. *pl. 67, f. 257;* Trans. Linn. Soc. 24: *pl. 51, f. 3, 5.*

Cotype material of this species has been examined. Also cotype material of *Peziza scabrosa* Cooke has been examined and found to be identical. The species is common.

19. **Lamprospora nigrans** (Morgan)

Peziza nigrans Morgan, Jour. Cin. Soc. Nat. Hist. 18: 43. 1895.
Detonia nigrans Sacc. Syll. Fung. 14: 747. 1899.

Plants at first cup-shaped and circular in outline, becoming plane and more or less irregular, hymenium black or blackish, externally smoky-pallid and smooth, attached to the soil by slender fibers, reaching a diameter of 1 or 2 cm.; asci cylindric or subcylindric and much elongated; spores 1-seriate, at first smooth, becoming rather coarsely warted and reaching a diameter of about 9 μ, subhyaline to smoky-brown; paraphyses thickened above and dark colored.

On burnt ground.

TYPE LOCALITY: Preston, Ohio.

DISTRIBUTION: Known only from the type locality.

The species is distinguished from *L. trachycarpa* to which it is closely related by the smooth exterior of the plants and the very small size of the asci and spores. Cotype material has been studied.

20. **Lamprospora leiocarpa** (Curr.)

Peziza leiocarpa Curr. Trans. Linn. Soc. **24**: 493. 1864.
Plicaria foveata Fuckel, Symb. Myc. 326. 1869.
Detonia leiocarpa Sacc. Syll. Fung. **8**: 105. 1889.
Detonia foveata Sacc. Syll. Fung. **8**: 105. 1889.
Plicaria leiocarpa Rehm, Rabenh. Krypt. Fl. **1**^{3}: 994. 1896.

Plants gregarious, at first globose and closed, opening and becoming shallow cup-shaped, at length almost entirely flattened, and irregularly undulated and lobed, hymenium olivaceous-brown; asci clavate, becoming subcylindric; spores at first irregularly 2-seriate, becoming 1-seriate at maturity, globose, hyaline, remaining entirely smooth, usually with one large oil-drop, about 10–12 μ in diameter; paraphyses enlarged above and adhering together.

On burnt ground.

TYPE LOCALITY: Ascot Heath, Great Britain.

DISTRIBUTION: California; also in Europe.

ILLUSTRATIONS: Trans. Linn. Soc. **24**: *pl. 51, f. 4, 6;* Boud. Ic. Myc. *pl. 304*.

Cotype material of this species has been examined. The only American specimens examined were collected by Dr. Harkness in California. This species differs from *L. trachycarpa,* which it resembles, in having permanently smooth spores.

21. **Lamprospora Planchonis** (Dun.)

Plicaria Planchonis Dun.; Boud. Bull. Soc. Myc. Fr. **3**: 92. 1887.

Plants gregarious or scattered, sessile, hemispherical or nearly plane, usually regular in form but occasionally irregularly contorted, margin rough, exterior of cups minutely roughened or warted, entire plant very dark purple, exterior almost black, hymenium a little lighter, flesh with transmitted light bright

purple and both asci and paraphyses surrounded with purple coloring matter which can be partially extracted with water from the dried plants, 5–8 mm. in diameter; asci cylindric, with a slender stem, about $200 \times 13–15\,\mu$; spores 1-seriate, perfectly globose, at first hyaline with one and sometimes several oil-drops, becoming pale purplish (as are also the paraphyses and asci), smooth or very minutely roughened, at maturity about $10–12\,\mu$ in diameter; paraphyses clavate, about $6\,\mu$ in diameter at their apices, filled with purple granules.

On sandy soil by roadsides, hillsides and on sand-dunes.

TYPE LOCALITY: France.

DISTRIBUTION: Common in the Bermudas; also in Europe.

ILLUSTRATIONS: Bull. Soc. Myc. Fr. 3: *pl. 8;* Boud. Ic. Myc. *pl. 309.*

This little purple fungus is the commonest cup-fungus in the Bermudas, occurring by roadsides and on hillsides in pastures and open places. Numerous collections were made by Stewardson Brown, N. L. Britton and the writer during the winter of 1912. So far as I am aware, this is the first record of the species from North America. A closely related species, *Peziza Persoonii,* is said to differ in having rough spores. No specimen of the latter species has been seen by the writer from North America.

22. **Lamprospora lobata** (Berk. & Curt.)

Peziza lobata Berk. & Curt. Jour. Linn. Soc. **10**: 365. 1869.
Barlaea lobata Sacc. Syll. Fung. **8**: 117. 1889.

Plants scattered, and shallow cup-shaped to nearly plane or with the margin slightly elevated and undulated or lobed; hymenium dull orange, paler below, about 5–12 mm. in diameter; asci cylindric or subcylindric, $15–18\,\mu$ in diameter and of variable length but usually about $250\,\mu$; spores 1-seriate, at first smooth, becoming rough at maturity, roughenings consisting of four to six tubercles of variable size which appear beyond the periphery of the spore and with several more or less indistinct lines or bands extending across the surface of the spore in various directions resembling pieces of coarse twine wound about its surface, the inequality in the size of the tubercles giving the mature spore a rather irregular form, entire spore $12–15\,\mu$ in diameter, hyaline; paraphyses very slender, about $1–2\,\mu$ in diameter and scarcely enlarged at their apices.

On the ground.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATIONS: Cooke, Mycogr. *pl. 69, f. 265.*

A cotype specimen of this species has been studied. The species is well-marked by its size and by the peculiar markings of the spores, which are not mentioned in the original description.

23. Lamprospora polytrichina (Rehm)

Detonia polytrichina Rehm, Krypt. Fl. 1^3: 1269. 1896.

Plants gregarious, sessile, expanding, becoming nearly plane or shallow cup-shaped, margin entire and often wavy, reaching a diameter of 5 mm., hymenium bright orange, externally lighter. whitish and more or less pruinose; asci cylindric or subcylindric, gradually tapering near the base, reaching a length of 200–225 μ and about 17 μ thick near the apex; spores 1-seriate, entirely globose, with one or sometimes several oil-drops, smooth, hyaline, 15–17 μ in diameter; paraphyses slender, slightly enlarged above, straight or slightly curved.

On soil among moss, especially *Polytrichum.*

TYPE LOCALITY: Europe.

DISTRIBUTION: Minnesota; also in Europe.

ILLUSTRATIONS: Cooke, Mycogr. *pl. 13, f. 50.*

The only specimens of this species examined from America were those collected by Miss Hone in Minnesota (No. *938*). The species has been confused with *Peziza Polytrichi* Schum.

DOUBTFUL SPECIES

Peziza exasperata Berk. & Curt. Grevillea **3**: 152. 1874.

The plants are described as one-half inch across, externally warted and with the margin inflexed, spores rough and about 12 μ in diameter.

The species was collected in Alabama by Peters.

Peziza globifera Berk. & Curt. Jour. Linn. Soc. **10**: 366. 1869.

A Cuban species with smooth spores. My only knowledge of this and the preceding species is based on the examination of microscopic slide of the spores.

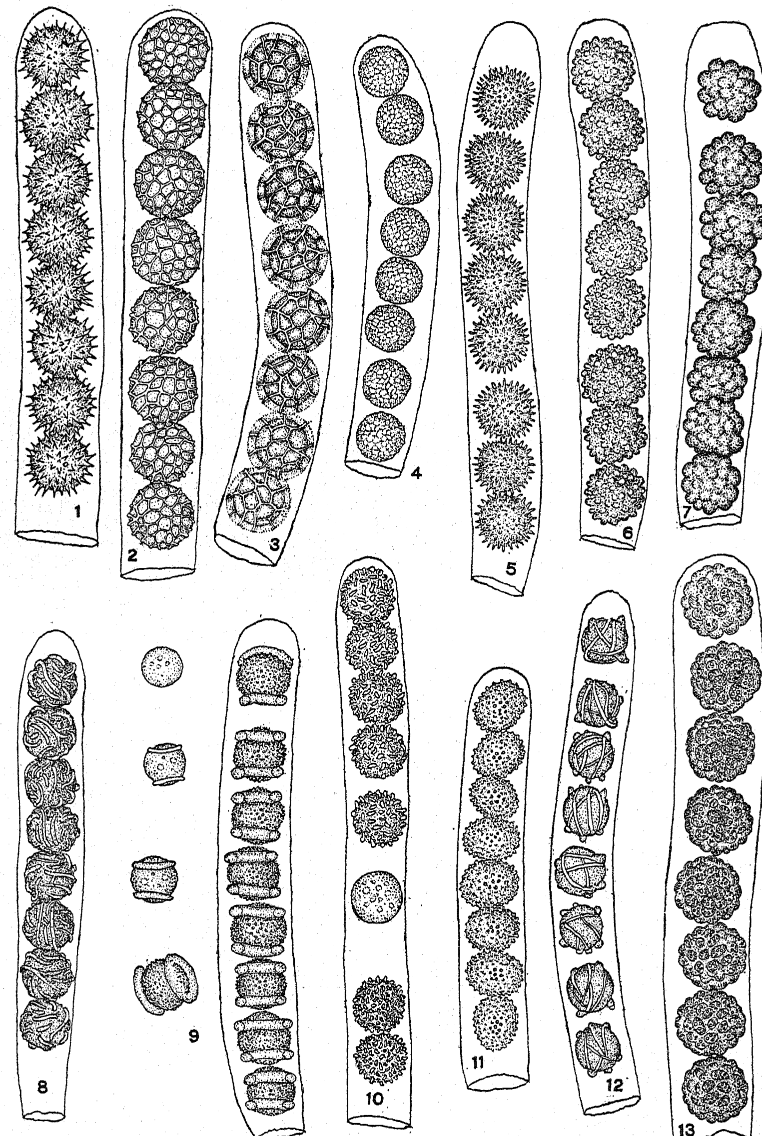
Barlaea lacunosa Ellis & Ev. Proc. Acad. Nat. Sci. Phila. **1894**: 347. 1895.

This species was described from material collected on the bark of some coniferous tree in Newfoundland. The type has been studied and both the habitat and general characters of the plant indicate that it is a *Pithya*, which genus is rather closely related to *Lamprospora*. Whether it is a distinct species I am unable to say. The plants are larger and more convolute than most specimens of *Pitya vulgaris* Fuckel, but some specimens of this species approach it in size. If it is not the same species, Ellis's plant is at least very closely related to *P. vulgaris*.

EXPLANATION OF PLATE CXIV

This plate contains spores of the following species of *Lamprospora* drawn with the aid of the camera lucida to a common scale.

1. *Lamprospora Crec'hqueraultii* (Crouan) Boud.
2. *Lamprospora Crouani* (Cooke) Seaver.
3. *Lamprospora areolata* Seaver.
4. *Lamprospora dictydiola* Boud.
5. *Lamprospora spinulosa* Seaver.
6. *Lamprospora tuberculatella* Seaver.
7. *Lamprospora tuberculata* Seaver.
8. *Lamprospora ascoboloides* Seaver.
9. *Lamprospora annulata* Seaver.
10. *Lamprospora trachycarpa* (Curr.) Seaver.
11. *Lamprospora Wrightii* (Berk. & Curt.) Seaver.
12. *Lamprospora lobata* (Berk. & Curt.) Seaver.
13. *Lamprospora Maireana* Seaver.



LAMPROSPORA

NOTES ON UREDINOPSIS MIRABILIS AND OTHER RUSTS

W. P. Fraser

A few culture experiments were carried on during the season of 1913, and, though nothing new was established by these cultures, yet, since some of them confirm important results that rest only on the previous experiments and observations of the writer, a brief record may be of interest.

Little culture material could be found in the vicinity of Macdonald College, so that the writer was dependent on the generosity of the following who contributed material for the experiments: Professors R. Matheson and H. W. Smith, of the Nova Scotia Agricultural College, Truro; Mr. Robert Inglis, Pictou, N. S.; Miss Muriel Macrae, Durham, N. S.; and Mr. W. H. Brittain, Plant Pathologist of British Columbia. To these, the writer wishes to express his sincere thanks.

Uredinopsis mirabilis (Peck) Magn.

Teliosporic material of this rust collected at Truro, N. S., was placed in a moist chamber until the teliospores were germinating freely. It was then suspended above a young plant of *Abies balsamea* (L.) Mill. on May 15th. Pycnia were present on the leaves on May 23d and aecia in abundance on June 1st. Another sowing on May 15th gave pycnia on May 25th followed by abundant aecia. A third sowing on May 16th was followed by pycnia on May 27th and aecia by June 3d, both in abundance. Two other sowings were made later with success, but the infection was not so marked, probably owing to the shoots being more mature. Six plants of *Abies balsamea* obtained at the same time and place were kept as checks and remained free from infection.

The species of the genus *Uredinopsis* are not separated by any marked morphological differences, also a number of them have

their aecia on *Abies balsamea,* so the question arises whether they are distinct or should be included under one species. To obtain cultural evidence bearing on this matter, the following experiments were made.

The aeciospores of *Uredinopsis mirabilis* obtained by the experiment just described were placed in distilled water, and by means of an atomizer were sown on the following ferns on June 14th: *Onoclea sensibilis* L., *Aspidium Thelypteris* (L.) Sw., *Osmunda Claytoniana* L., *O. regalis* L., *Phegopteris Dryopteris* (L.) Fée. Uredinia were noticed on June 21st on *Onoclea sensibilis* and soon became abundant. There was no infection of the other ferns. Another sowing on June 16th of culture aeciospores on *Onoclea sensibilis, Asplenium Filix-femina* (L.) Bernh., *Osmunda Claytoniana* and *Aspidium Thelypteris* gave abundant uredinia on *Onoclea sensibilis* by June 24th, but no infection of the others. A third sowing on June 26th on *Aspidium Thelypteris, Asplenium Filix-femina, Onoclea sensibilis* and *Phygopteris Dryopteris* was followed by abundant uredinia on *Onoclea sensibilis* but no infection of the other plants. A number of checks of *Onoclea sensibilis* remained free from infection.

These experiments confirm the work of last year and indicate clearly that *Uredinopsis mirabilis* is a distinct species.[1]

MELAMPSORA MEDUSAE Thüm.

Teliosporic material of this rust collected near Pictou, N. S., was sown on young trees of *Tsuga canadensis* on May 28th. Pycnia were present by June 5th, and aecia were first noticed appearing on June 8th, both in great abundance. Five trees kept as checks showed no infection. Branches of *Tsuga canadensis* bearing cones were placed in water and germinating teliosporic material suspended above the cones on June 20th. Pycnia were present on the cones on June 27th and were soon abundant, but only one matured aecia. Doubtless the failure to mature aecia was due to the unhealthy condition of the cones, most of them dying before the aecia had time to mature.

Attempts were made to infect *Larix laricina* (Du Roi) Koch. in the field, but without success. Two sowings of germinating

[1] See MYCOL. 4: 236. 1913.

teliosporic material on a flourishing young tree of the same species in the laboratory also failed.

From field observations and culture experiments described in this and previous papers, the writer concludes that the *Melampsora* on *Populus grandidentata* in eastern Canada has its aecia on the leaves, young twigs and cones of *Tsuga canadensis* and does not infect *Larix laricina*.[2] It may be that the rust on *Populus grandidentata* is a distinct species as Arthur[3] has shown that *Melampsora Medusae* on *P. deltoides* and *P. tremuloides* has aecia on *Larix*, but for the present it seems best to regard it as a specialized form of *Melampsora Medusae*. Attempts to infect *Populus deltoides* with the aeciospores obtained from the culture failed.

PUCCINIASTRUM MYRTILLI (Schum.) Arth.

Teliosporic material of this rust on *Gaylussacia resinosa* (Ait.) T. & G., collected at Isle Perrot, P. Q., was sown on *Tsuga canadensis* on May 28th. Pycnia were present on June 9th and aecia on June 16th, both in abundance.[4]

CALYPTOSPORA COLUMNARIS (Alb. & Schw.) Kühn

Germinating teliosporic material of this rust on *Vaccinium pennsylvanicum* Lam., collected at Pictou, N. S., was sown on *Abies balsamea* on May 15th. Aecia were noticed on June 3d and were mature by June 12th. No pycnia were formed.[5]

PERIDERMIUM HARKNESSII Moore

Attempts were made with the aeciospores of this form collected at Vernon, B. C., to infect *Commandra umbellata* (L.) Nutt., but without success. It was doubtful, however, if the aeciospores were in good condition when sown.

SUMMARY OF CULTURES DESCRIBED IN THIS ARTICLE

Uredinopsis mirabilis Magn. Five successful sowings of teliospores from *Onoclea sensibilis* L. on *Abies balsamea* (L.) Mill.

[2] See MYCOL. 3: 188. 1912; 5: 238. 1913.

[3] Jour. Myc. 10: 13. 1904; 11: 52. 1905; 12: 13. 1906.

[4] See MYCOL. 5: 237. 1913.

[5] See MYCOL. 4: 177. 1912.

Three successful sowings of culture aeciospores on *Onoclea sensibilis* L. but failure to infect *Osmunda Claytoniana* L., *Osmunda regalis* L., *Aspidium Thelypteris* (L.) Sw., *Asplenium Filix-femina* (L.) Bernh., and *Phegopteris Dryopteris* (L.) Fée.

Melampsora Medusae Thüm. Teliospores from *Populus grandidentata* Michx., infected *Tsuga canadensis* (L.) Carr, but failed to infect *Larix laricina* (DuRoi) Koch.

Pucciniastrum Myrtilli (Schum.) Arth. Teliospores from *Gaylussacia resinosa* (Ait.) T. & G., infected *Tsuga canadensis* (L.) Carr.

Calyptospora columnaris (Alb. & Schw.) Kühn. Teliospores from *Vaccinium pennsylvanicum* Lam., infected *Abies balsamea* (L.) Mill.

MACDONALD COLLEGE,
PROVINCE OF QUEBEC.

OBSERVATIONS ON THE USE OF RIDGWAY'S NEW COLOR-BOOK.[1,2] THE COLOR OF THE SPORES OF VOLVARIA SPECIOSA FR.

L. C. C. Krieger

In using the recently published book, "Color Standards and Color Nomenclature," by Ridgway, the writer was confronted with certain difficulties which operate against exactness in color determination, viz.: the appearance of the complementary of an adjacent color in the one under observation; the darkening or lightening effects of backgrounds of varying degrees of luminosity; and the effect of area on colors.

As these difficulties will be encountered by others who may have occasion to consult this valuable repository of color tones, an account of some tests will doubtless prove of interest.

The writer wished to ascertain the precise color of a spore-print of the gill-fungus, *Volvaria speciosa* Fr. The print was about 15 cm. in diameter, and so dense as to cover completely the white paper underneath. On comparing the entire area of the print with the small color squares in the book, it was found that a tone somewhere between *l* and *k* of column 13, Pl. *III*, corresponded with the tone of the spore-deposit.[3]

1 Color Standards/and/Color Nomenclature/by/Robert Ridgway, M.S., C.M.Z.S., etc./Curator of the Division of Birds, United States/National Museum./With Fifty-three Colored Plates/and/Eleven Hundred and Fifteen Named Colors./Washington, D. C./1912./Published by the Author./(8 mo., colored frontispiece, pp. (I) II–III (IV), (1) 2–43 (44). Reviewed by P. L. Ricker in Mycologia 5: 172–174. March, 1913.)

2 While the discussion here presented is confined to Ridgway's book, the deductions are applicable to any work which attempts to standardize colors by giving the colors themselves.

3 The tests here recorded were conducted in a room, near a good-sized window in the north wall. Sky clear. No other illumination. No reflections from strongly colored objects outside. Wall-paper and near-by objects not conspicuous in color. Every test was verified by two persons.

But having learned, through experience, that colors appear brighter when spread over large surfaces than when confined to smaller ones, it was decided to cover the spore-print entirely with a piece of white paper measuring 15.5 cm. by 29 cm., and provided in the center with an aperture of the exact size of the color squares; a contrivance known as an excluder. Placing this excluder over the print so that only a small patch of the spore-covered surface showed, and then comparing this patch with the squares, it was learned that the tone 13 *m* on Pl. *III* matched perfectly, the reduction in area having had a darkening effect.

For the next test, a piece of carbon paper of the same size as the white sheet was procured, and, after providing it with an aperture of the same dimensions as the other, comparison was made. This time the spores agreed exactly with square *i*, column 13′, pl. *XV*, a tone, it will be noticed, very much lighter than either of those determined upon in the foregoing tests.

Finally, it was concluded to equalize conditions absolutely, both as to size of aperture and color of paper. Two sheets of the identical color of the mounts in Color Standards, cut to the size adopted for these tests, were applied, one to the print, the other to the squares, with the result that the spore-color tallied accurately with 13′ *k*, on Pl. *XV*,—again a different tone.

These tests may be repeated by anyone who will follow the methods described. Any color will answer the purpose, though a critical one, such as an indeterminate brown of medium depth, will exhibit the mutations more markedly. With excluders of a lively color the effect is quite surprising, as another set of tests with a sheet colored Cendre Green (Pl. *VI*, 35 *b*) demonstrates.

Except for the color, the sheet was in every respect like those used previously, but before applying it, an experiment was performed that again exhibited the effect of increased area on colors. It was found that when any part of the surface was brought in direct contact with the square of Cendre Green, the agreement was perfect; when, however, the surface was viewed as a whole, the color approximated rather closely Vanderpoel's Green (Pl. *VI*, 33 *b*), a yellower green than Cendre Green.

With this sheet the following changes were produced in some squares chosen at random:

Pl. *II* 11 k = Pl. *II* 9 j
Pl. *II* 11 m = Pl. *II* 9 m
Pl. *III* 15 m = Pl. *III* 13 m (almost)
Pl. *IV* 23 f = Pl. *IV* 21 f
Pl. *IV* 23 k = Pl. *IV* 20 k
Pl. *XXXIX* 5''' d = Pl. *XXXIX* 1''' c
Pl. *XL* 21''' f = Pl. *XXXIX* 14''' e

If one desired, tests might be carried on with sheets representing all of the colors of the spectrum, but in each test it would be found that the color tested had undergone a change of aspect, the degree and direction depending upon the color in juxtaposition. Indeed, by the use of a set of differently colored excluders a large number of new tones, each one a standard, might be obtained; but unfortunately, it would not be possible to turn these new tones to account, as the excluder, applied to the color to be compared, would itself have to be excluded, and without this important factor, comparison would be reduced to the hit-or-miss method we are endeavoring to eliminate.

In view of the discomforting deductions which cannot but be drawn from these tests, one is bound to accept the conclusion, long ago arrived at by artists, physicists, and others, that colors, as perceived by the human eye, are of an illusive nature and not fixed in the way generally supposed. This conclusion accepted, it behooves the devotees of the descriptive sciences to agree upon some means by the aid of which this source of error may be controlled.

The writer would suggest the issuing of two excluders (in supplementary form), each measuring 15.5 cm. by 29 cm., and colored to match the mounts in Color Standards. In the center of each, there should be an aperture of the size of the color squares. In addition, a note might be included enjoining the use of the excluders when accurate records are to be made. The note ought to state further, that users of the book, when referring to a tone, should indicate whether the excluders were employed. The abbreviation "+ std. excl." (plus standard excluders), added to a symbol, would suffice to show whether the observer had availed himself of this necessary adjunct in the work of color discrimination.

U. S. DEPARTMENT OF AGRICULTURE.

NEW OR INTERESTING FUNGI

David Ross Sumstine

(With Plates 115–117, Containing 16 Figures)

Hormisciopsis gen. nov.

Pulvinate, effused, gelatinous, collapsing when dry; mycelium well developed, filiform, branched; sporophore not differing from the mycelium, erect or suberect; spores in chains, bright-colored.

This genus differs from *Hormiscium* in its gelatinous character. In gross appearance it is not unlike some species of Tremellaceae, particularly species of *Exidia* or *Guepinia*. The manner of production of spores separates it entirely from this group.

Hormisciopsis gelatinosa sp. nov.

Pulvinate or effused, contorted, plicate, compact, appearing as though oozing out of the substratum, red to dark-red; mycelium filiform, branched; sporophores not differentiated from the mycelium; spores in chains, the chains branched, globose to ellipsoid, guttulate, somewhat granular, $5–6 \times 6–10\ \mu$.

On decayed wood, Fern Hollow, Allegheny Co., Pennsylvania, August, 1907.

The type specimens are in the Carnegie Museum, Pittsburgh, Pa.

Arthrosporium album sp. nov.

Plants gregarious, mycelium scanty; stroma conic or cylindric, 0.5–1 mm. high, white, composed of a fascicle of parallel hyphae, the fertile hyphae becoming free along the stroma or spreading above and forming a small head; spores borne on sterigmata on the swollen ends of the fertile hyphae; spores hyaline, 3-septate, guttulate, cylindric-fusiform, $5–8 \times 25–30\ \mu$.

On decayed log, Fern Hollow, Allegheny Co., Pennsylvania, 1912.

The genus *Arthrosporium* is used simply as a pigeonhole for this species. Its affinities are with several genera. It might be

placed with equal propriety in *Atractium* or *Harpographium*. *Atractium* differs from *Arthrosporium* in the shape of the spores; *Harpographium* differs in the colored hyphae and in the simple spores.

The type specimens are in the Carnegie Museum, Pittsburgh, Pa.

PHYLLOSTICTA ATRIPLICIS Desm.

From published descriptions, *Phyllosticta Atriplicis* Desm. and *Septoria Atriplicis* (West.) Fuckl. may be the same species. I have not seen the type specimens of either species and therefore cannot say definitely that such is the case, but specimens collected on leaves of *Atriplex hastata* L. during the summers of 1909, 1910, 1911, and 1912 may throw some light on the matter. The specimens were collected at different places in Wilkinsburg and always showed remarkable uniformity in growth and development.

The examination of fresh specimens showed pycnidia with long, guttulate, and apparently non-septate spores. The spores in old dry specimens appeared to be distinctly septate. This peculiar condition in spore character made the determination of the plants difficult. The long non-septate spores indicated the genus *Phoma* or *Macrophoma;* the older septate spores pointed to the genus *Septoria*.

It is probable that the septation in the older spores is due to the contraction of the protoplasmic mass in drying and therefore the septa are not true but only apparent.

Three species of *Phoma* are reported as growing on *Atriplex: Phoma longissima, Atriplicis, Westendorpii.* The spore measurements for these three species range from 4–10 μ in length. The spores in my specimens are more than twice that length and, consequently, cannot be referred to any of these species.

Phyllosticta Atriplicis Desm. is described as having spores cylindric, ovate, straight or curved, 3–6-guttulate. The length of the spores is not given. *Septoria Atriplicis* (West.) Fuckl. has cylindric or subfusoid spores, 4.5–5 $\times$ 25–35 μ, spuriously 1–2–3-septate. The spores in this latter species agree fairly well with the spores in my specimens. It may be possible, then, that these

two species are the same, the description of the one being drawn from fresh or young plants and the description of the other from old and dry plants.

If the arbitrary distinction between *Phyllosticta* and *Macrophoma,* the difference in the length of spores, is to be maintained, this plant should be referred to the genus *Macrophoma.*

The following is a description of my specimens:

The discolored spots are from 1–5 millimeters in diameter, white or brownish-white, irregularly scattered over the leaves. The pycnidia are subepidermal, globose-lenticular, generally epiphyllous but sometimes hypophyllous, brown to black, with distinct, circular ostiole. The spores are cylindric, straight or a little curved, obtuse at the ends, guttulate, apparently septate in old specimens, $4.5–5.5 \times 20–30\ \mu$.

Streptothrix pereffusa sp. nov.

Effused, dense, confluent, olive-green to black; mycelium septate, colored, branching; sporophores erect, septate, diffusely branched, branches flexuous; spores borne at the ends and the sides of the branches, colored, ovoid to ellipsoid, $5–8\ \mu$.

On bark, Bemus Point, N. Y., July, 1913.

This species is closely related to *S. atra* B. & C. It may be separated from the latter by the color, the smooth sporophores, and the dense growth.

The following species have been reported from America: *S. abietina* Pk., *S. glauca* E. & E., *S. cinerea* Morg., *S. fusca* Corda, *S. atra* B. & C.

It is unfortunate that the name *Streptothrix* is used for a genus in the Chlamydobacteriaceae. Cohn established this genus in 1854, but Corda had already used the name for a genus in the Dematiaceae in 1839.

Oidium album sp. nov.[1]

Effused, forming a thin floccose layer over the substratum, white changing to dirty-white in drying; mycelium branched, septate; sporophores erect or suberect, simple or branched; spores concatenate, hyaline, ovoid to ellipsoid, $12–14 \times 16–22\ \mu$.

On bark and *Coriolus abietinus,* Bemus Point, N. Y., July, 1913.

[1] See MYCOLOGIA 5: 47. 1913.

The type specimens are deposited in the Carnegie Museum, Pittsburgh, Pa.

Polyscytalum flavum sp. nov.[2]

Effused, floccose, white at first, then yellow to sulphur-yellow; mycelium scanty; sporophores scarcely differing from the mycelium; spores in chains, chains branched or simple, cylindric, truncate at the ends, $3 \times 16\,\mu$.

On decayed wood, Bemus Point, N. Y., July, 1913.

This species resembles *Cylindrium flavo-virens* Bon., but the spores are larger and not curved.

The type specimens are in the Carnegie Museum, Pittsburgh, Pa.

Vaginata umbonata sp. nov.

Pileus thin, convex or expanded, 3.5–5 cm. broad, distinctly conically umbonate, covered with triangular scales arranged in somewhat concentric zones, tan-colored, scales darker, margin thin, smooth; gills 3–5 mm. broad, ventricose, sinuate, adnexed; stem 9–12 cm. long, solid, equal, concolorous, with long bulbous root; volva fimbriate, adhering closely to the stem; spores ovoid to ellipsoid, 5–7 μ (*pl. 117. f. 1*).

Growing in sandy soil at Ohiopyle, Pennsylvania, August, 1908.

This species is closely related to *Amanitopsis adnata* (Smith) Sacc. in its adnate gills; to *Agaricus* (*Amanitopsis*) *urceolatus* Viv. in its umbonate pileus; and to *Amanitopsis volvata* (Peck) Sacc. in its floccose-scaly pileus. It is easily separated from these species by its conic umbo, concentrically arranged scales, and fimbriate volva.

The type specimens are in the Carnegie Museum, Pittsburgh, Pa.

Marasmius Morganianus sp. nov.

Pileus membranaceus, convex, sometimes nearly expanded, glabrous, slightly rugulose on the margin, reddish-brown or rufescent, center darker, 2–5 mm. broad; gills few, subdistant, broad, adnate, pallid at first, darker when old; stem 2–3 cm. long, slender, equal, rufescent at the base, pallid at the top, covered with a white pubescence; spores fusoid or ellipsoid, 3–6 μ.

On fallen leaves, Somerset, Pennsylvania, August, 1906.

[2] See MYCOLOGIA **5**: 55. 1913.

In correspondence with Prof. A. P. Morgan in 1906 relative to some species of *Marasmius,* Mr. Morgan said concerning this plant, "I think it is something new, near *M. atro-rubens* Berk." The description was then written and submitted to Mr. Morgan for publication in the *Journal of Mycology.* For various reasons, it was not published at that time but the plant may be found by other collectors, and the description is therefore published.

The type specimens are in the Carnegie Museum, Pittsburgh, Pa.

PEABODY HIGH SCHOOL,
PITTSBURGH, PA.

EXPLANATION OF PLATE CXV

Figs. 1–3. *Hormisciopsis gelatinosa* Sumstine. Figs. 1–2 show mycelium, sporophores and spores highly magnified. Fig. 3 shows a group of plants nearly natural size.

Figs. 4–5. *Arthrosporium album* Sumstine. Fig. 4 shows stroma and spores highly magnified. Fig. 5, a group of plants nearly natural size.

Figs. 6–8. *Phyllosticta Atriplicis* Desm. Figs. 6 and 7 show leaves of *Atriplex hastata* with discolored spots containing pycnidia. Fig. 8 shows pycnidia and spores highly magnified.

EXPLANATION OF PLATE CXVI

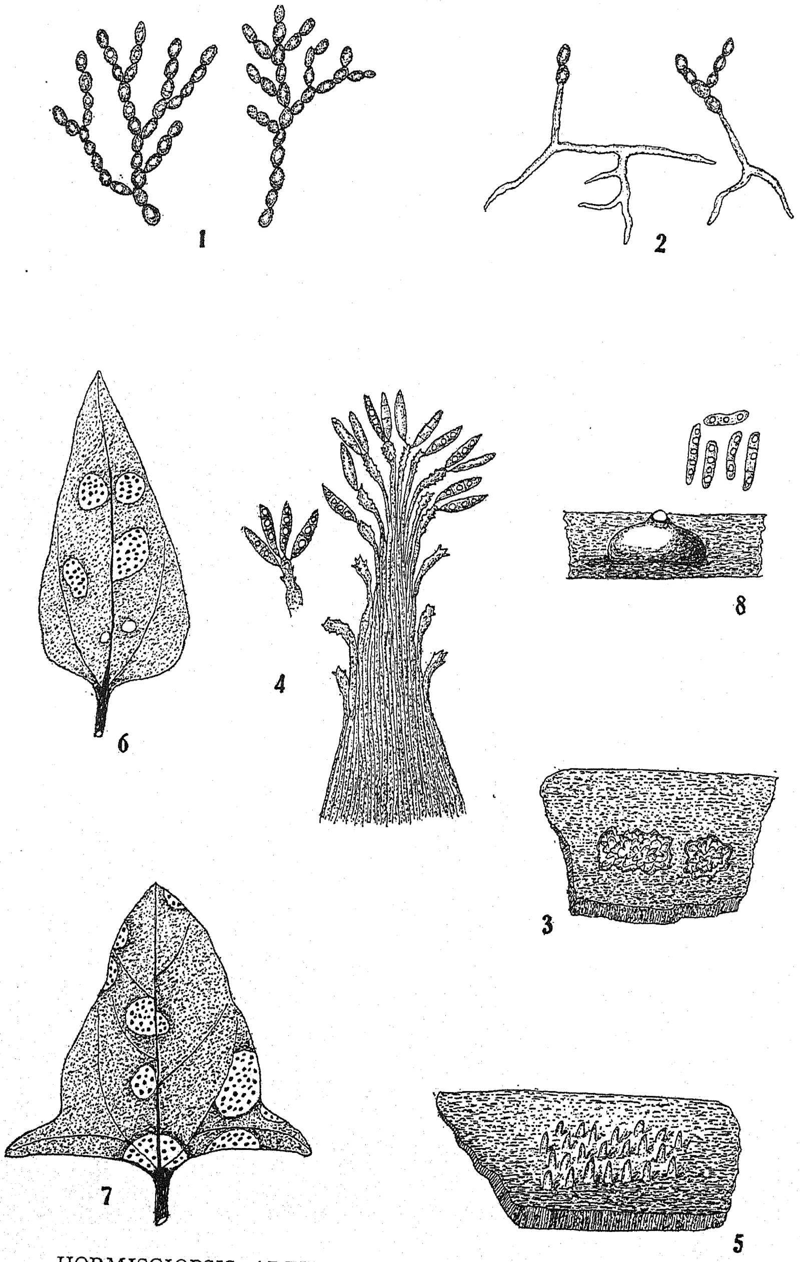
Fig. 1. *Oidium album* Sumstine; mycelium, sporophores and spores.

Fig. 2. *Polyscytalum flavum* Sumstine.

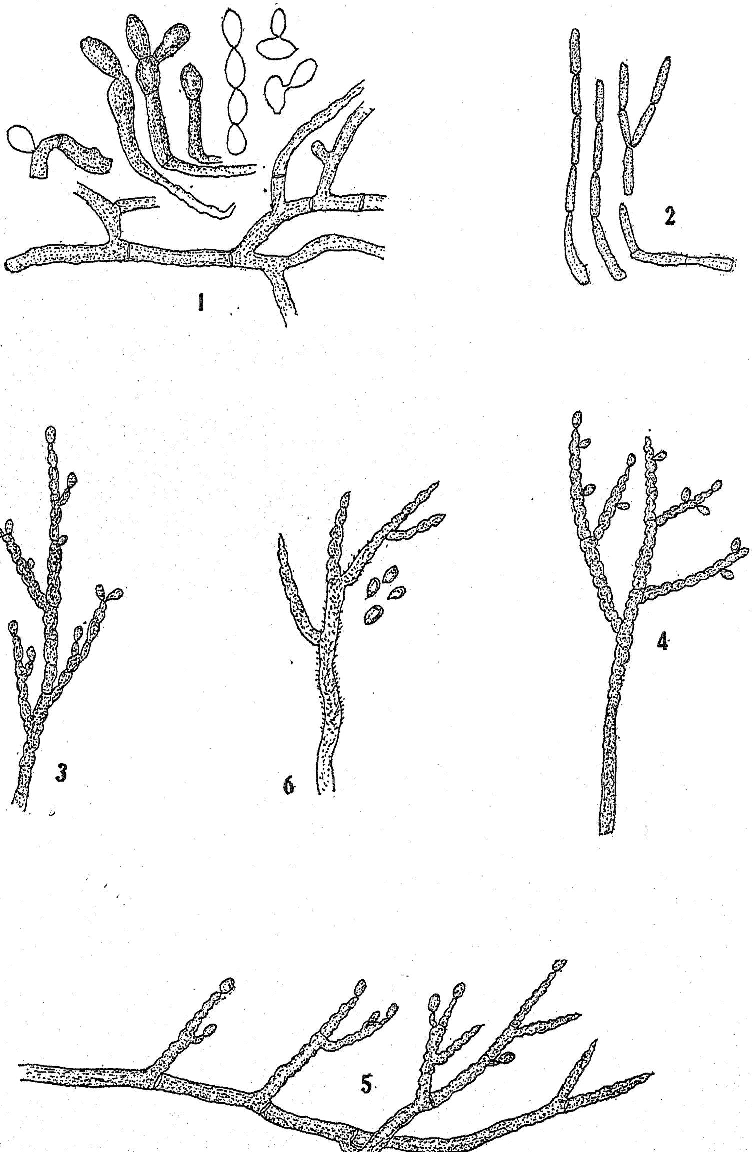
Figs. 3–5. *Streptothrix pereffusa* Sumstine; sporophores and spores

Fig. 6. *Streptothrix atra* B. & C.

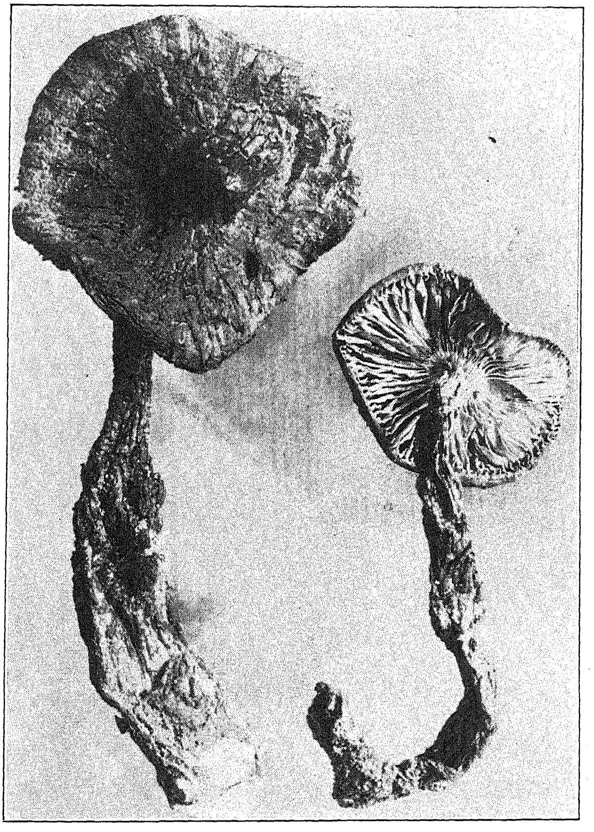
The figures were drawn with the aid of the camera lucida and are highly magnified.



HORMISCIOPSIS, ARTHROSPORIUM AND PHYLLOSTICTA



OIDIUM, POLYSCYTALUM AND STREPTOTHRIX



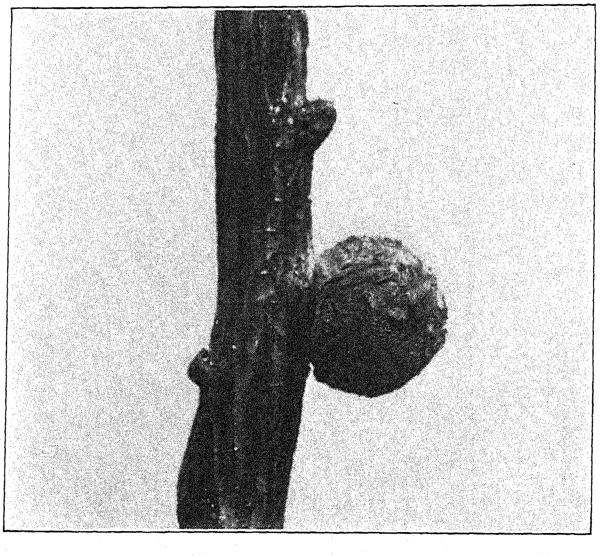


FIG. 1 (UPPER). VAGINATA UMBONATA SUMSTINE
FIG. 2 (LOWER). AERIAL GALL OF THE MESQUITE

AERIAL GALLS OF THE MESQUITE

F. D. Heald

[With Figure 2 on Plate 117]

During work upon a plant disease survey in the vicinity of San Antonio, Texas,[1] my attention was called to the frequent occurrence of galls upon the twigs and branches of the mesquite (*Prosopis glandulosa* Torr.). The following quotation is from the publication dealing with the survey mentioned: "The large limbs and smaller branches of the mesquite sometimes show abnormal enlargements which are frequently globular or sometimes elongated and sometimes greatly exceed the diameter of the branch on which they are produced. (Plate XV, figs. 2 and 3.) Specimens have been obtained ranging from 1 to 8 or 10 inches in diameter. The gall is produced by an abnormal growth of the wood, and cross sections of galls always show small brown specks where the wood cells are more or less disintegrated. These are distributed throughout the entire woody region.

"These galls are not of insect origin, and cultural work attempted has as yet failed to connect either bacteria or fungi with the disease, although both have been obtained."

The crown-gall organism, *Bacterium tumefaciens* Erw. Sm. & Townsend was strongly suspected of being the cause of the galls, but at the time of writing the bulletin referred to the authors had obtained no direct evidence of such causal relation. No opportunity was afforded for detailed work on this subject, but Dr. Erwin F. Smith, of the Bureau of Plant Industry, very kindly furnished some cultures of *B. tumefaciens* which were used with the class in plant pathology in making some inoculations on the mesquite.

The inoculations were all made on a large tree growing under natural conditions on the campus of the University of Texas. A

[1] Heald, F. D. and Wolf, F. A. A plant disease survey in the vicinity of San Antonio, Texas. Bull Bur. of Pl. Ind. U. S. Dept. Agr. **226**: 72. 1912.

small cutting needle was used to make a slit extending through the cortex and reaching the cambium, and the inoculum was introduced into each incision with a sterile needle. No protection of any kind was given by wrappings. An equal number of control incisions were made at the time. The inoculations were made on April 13, 1911, and a dry period followed. Conditions were so unfavorable for growth during the following months of spring and summer that successful inoculations were not anticipated. The results are given in the following table:

INOCULATIONS OF MESQUITE WITH B. TUMEFACIENS

Made 4-13-1911; record completed 9-21-1911

Strain of *B. tumefaciens* used	Age of shoots inoculated	Diameter of shoots	No. of inoculations	Result		No. of controls	Result
				No. of galls	Size of galls		
Hop.....	3 yrs.	8–10 mm.	10	1	8 mm.	10	All healed
Daisy....	3 yrs.	8–10 mm.	10	0		10	All healed
Daisy....	2 yrs.	6 mm.	10	2	13 and 10 mm.	10	All healed
Daisy....	1 yr.	4 mm.	10	1	15 mm.	10	All healed

Of the forty inoculations, four or ten per cent. proved successful, producing galls ranging in size from 8–15 mm. in diameter after five months and eight days, after which the record was discontinued. Two of the galls produced were nearly globular and showed a small surface of attachment (*pl. 116, f. 2*), one was somewhat flattened and elongated parallel with the axis of the shoot, and the fourth was globular-depressed. In no case did the control punctures show any abnormal growth, and all were perfectly healed when the record was completed.

The above record is not presented as conclusive evidence that the galls common on the mesquite throughout the southwest are of bacterial origin, but it at least affords a basis for this presumption. The inoculations reported do show at least that *B. tumefaciens* can produce aerial galls on the mesquite.

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NEWS AND NOTES

Nearly two hundred colored drawings of local fleshly fungi have recently been mounted in the swinging frames of the public museum of the New York Botanical Garden.

Dr. C. E. Lewis has resigned his position as associate in plant pathology in the Maine Experiment Station to enter private business.

Professor F. L. Stevens has resigned his position in the University of Porto Rico to become Professor of Plant Pathology in the University of Illinois. His address after February 1 will be Urbana, Illinois.

Dr. C. H. Kauffman, Assistant Professor of Botany in the University of Michigan, has been granted a research scholarship for February, 1914, to aid him in the preparation of manuscript for NORTH AMERICAN FLORA on the genus *Cortinarius*.

Leo E. Melchers, recently a graduate student and assistant in the Department of Botany at the Ohio State University, Columbus, Ohio, has been appointed assistant plant pathologist at the Kansas Agricultural Experiment Station, Manhattan, Kansas.

Mr. C. G. Lloyd, of the Lloyd Library and Museum, Cincinnati, Ohio, spent part of October and November at the Garden examining the collection of polypores. Mr. Lloyd has recently been to Cuba and Florida collecting specimens of this group of fungi.

The Fungi Which Cause Plant Diseases is the title of a book by Professor F. L. Stevens which has just been issued by Macmillan. The object of the book is to acquaint the student with the more important fungi which cause diseases of plants. A review of the book, which contains 754 pages and many illustrations, will appear in some future number of MYCOLOGIA.

In a preliminary paper in *Phytopathology* for December, 1913, W. H. Long discusses *Polyporus dryophilus* and *P. dryadeus* and the rots caused by them. He says that the former is known in Europe under at least three different names, and that Robert Hartig confused it with *P. dryadeus,* which causes in this country a serious rot in the roots of various species of oak.

Mr. Fred D. Fromme, formerly a graduate student at Columbia University, and Mr. H. C. Travelbee, graduate of Purdue University, have become assistants in the botanical department of the Indiana Experiment Station, filling positions formerly occupied by Dr. F. D. Kern and Mr. J. B. Demaree, who have gone to Pennsylvania State College. Their chief work will be in connection with the rust problems under investigation by the department.

The report of the botanist of New York State for 1912 appeared November 28 as Museum Bulletin 167. It contains descriptions of thirty-six new species of fungi and four colored plates of edible and poisonous species. *Amanita ovoidea* Bull. is reported from New York, and is put in the edible list. It is so very similar to the white form of *Amanita phalloides* that no one should think for a moment of using it for food. *Mycena splendidipes* Peck is described from Richmond County and is said to be poisonous. It is a beautiful species, with bright-yellow stipe and yellowish-brown to pinkish-brown pileus.

CANTHARELLUS CLAVATUS FROM DULUTH

Since the appearance of my article on the identity of *Cantharellus brevipes* and *Cantharellus clavatus* in MYCOLOGIA, September, 1913, I have received a box of fine specimens from Dr. S. M. Stoker, Duluth, Minnesota, who says he has often collected the plant in the neighborhood of Duluth and referred it to *Cantharellus brevipes* Peck. Most of the specimens are cespitose with the margin of the pileus thin and spreading like those shown in Plate 94. Some of the plants are branching. They agree with the Neebish specimens, although in some of them the spores are a

little shorter, not over 8μ in length. Dr. Stoker writes that some Poles who collected mushrooms for food knew the plants and called them *"pig's ears,"* which is the popular name for *Cantharellus clavatus* in parts of Europe. The species appears to be more frequent in the Lake Superior district than in the East, where the closely related *Cantharellus floccosus* is more frequently met with. I have never collected *Cantharellus floccosus* farther west than the Muskoka Lake region in Ontario. Specimens of that species have been sent to me recently, collected by S. E. Hutton in New Hampshire. The species has been described by Peck and Murrill and illustrated by Peck, Hard, and Nina Marshall. As noted by Peck, the two species, *Cantharellus floccosus* and *Cantharellus clavatus,* form a distinct group agreeing with each other in general characters, nature of the lamellae, and color of the spores. The two species differ in color and size of spores, and in the fact that *Cantharellus clavatus* is solid with the pileus truncate or but little depressed and nearly smooth, while *Cantharellus floccosus* has the pileus floccose-scaly and trumpet-shaped or infundibuliform and hollow to the base, with thin flesh. The stem in both species is normally short, but in *Cantharellus floccosus* it is sometimes lengthened and curved, extending deep into the mould. In all the collections I have seen, these distinctions have been marked. So far as I am aware, *Cantharellus floccosus* has not been identified with any European form

EDWARD T. HARPER.

A BOOK ON TROPICAL PLANT DISEASES[1]

While works on plant pathology are becoming quite numerous, the present book is a pioneer in a new field, as no other work in English attempts to cover in adequate fashion the diseases of tropical plants for the entire world. Indeed, the literature of the subject is so scattered that few libraries can offer adequate facilities for the study of tropical plant diseases without such a guide

[1] The Diseases of Tropical Plants. By Melville Thurston Cook, Ph.D., Pp. xi, 317. Frontispiece and 85 text figs. London, Macmillan and Company, Ltd. 1913. Price 8/6.

as the present work offers. For such an undertaking, the author's experience in Cuba is a most valuable asset, as it has brought him into first-hand contact with many of the troublesome diseases of the tropics. The book is well written and copiously illustrated, a very large percentage of the cuts being original. In this respect it is more fortunate than some other plant pathologies which have appeared in recent years with the majority of cuts borrowed. The practice of borrowing extensively detracts from the value of any work, as it gives the reader a feeling that he is dealing with a second-hand subject, whereas original illustrations appeal to him as accompanying live matter treated by one who is acquainted with the subject at first hand.

The preface states that the "work is intended primarily for the planter; but it is hoped that it may be of some service to the student." This will account for the method of treatment adopted in the work. The chapters are arranged in three groups, those dealing in a general way with the nature and causes of plant diseases, those treating of the diseases themselves, and those which discuss the prevention and cure of these diseases. In the first group of chapters, the physiology and structure of plants are briefly outlined and the nature and symptoms of disease discussed. This is followed by a comprehensive survey of the classification of fungi with especial reference to the disease-producing forms. Bacteria, slime moulds, and other causes of plant diseases are also taken up in this connection.

In the second group of chapters, which constitutes the body of the work, the various diseases are discussed in detail both as to their symptoms and cause, as well as methods for their treatment. Here the diseases are grouped according to their host plants, which is a great convenience to the planter for ready reference, while the student of the fungi themselves will find the taxonomic references in the preceding chapters. In this connection, it is quite interesting to note that on the crops grown in both temperate and tropical regions serious diseases in the one region may be entirely absent from the other, or if present of only secondary importance.

The chapters on the prevention and control of disease

emphasize sanitation and prevention rather that the attempt to cure, once the crop is attacked. Remedial measures are discussed in detail, both as to the preparation and the application of the treatment. These chapters should not prove the least valuable portion of the book from the planter's standpoint. The book closes with an extended bibliography which must prove of great value to the student of tropical diseases from whatever angle he may approach the subject.

This work occupies a field so different from that of most works on plant pathology that it should be welcomed by the practical man of affairs, while it must be of no small value to the plant pathologist and to the mycologist in the tropics, as well as to all students of tropical fungi.

GUY WEST WILSON.

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Lutman, B. F. The pathological anatomy of potato scab. Phytopathology **3**: 255–264. *f. 1–10.* O 1913.

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Metcalf, H. The chestnut bark disease. Yearbook Dept. Agr. **1912**: 361–372. *pl. 34–37.* 1913.

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Olive, E. W. Intermingling of perennial sporophytic and gametophytic generations in *Puccinia Podophylli*, *P. obtegens*, and

Uromyces Glycyrrhizae. Ann. Myc. **11**: 297–311. *pl. 15.* Au 1913.

Pammel, L. H., & King, C. M. Four new fungus diseases in Iowa. Iowa Agr. Exp. Sta. Bull. 131: 199–221. *f. 1–13.* Ap 1912.

Peck, C. H. Report of the state botanist, 1912. N. Y. State Museum Bull. 167: 5–137. *pl. 131, 132, IX, X.* 1 S 1913.

Includes twenty-six new species of extralimital fungi.

Rehm, H. Ascomycetes exs. fasc. 53. Ann. Myc. **11**: 391–395. 10 N 1913.

Includes American material.

Rehm, H. Ascomycetes novi. Ann. Myc. **11**: 396–401. 10 N 1913.

Includes *Pezizella dakotensis, Plicaria glacialis, Dasyscypha Ivae, Sphaerulina divergens, Leptosphaeria Onagrae,* spp. nov. from America.

Saccardo, P. A. Notae mycologicae. Ann. Myc. **11**: 312–325. Au 1913.

Includes *Macrophoma Brenckleana* and *Fusicoccum dakotense* spp. nov. from North Dakota.

Stewart, F. C. The persistence of the potato late-blight fungus in the soil. N. Y. Agr. Exp. Sta. Bull. 367: 357–361. O 1913.

Stoddard, E. M., & Moss, A. E. The chestnut bark disease. *Endothia gyrosa* var. *parasitica* (Murr.) Clint. Connecticut Agr. Exp. Sta. Bull. **178**: 5–19. *f. 1–8.* S 1913. [Illust.]

Stone, G. E. Diseases more or less common during the year. Ann. Rep. Massachusetts Agr. Exp. Sta. **25**: 38–40. Ja 1913.

Stone, G. E. A new rust. Ann. Rep. Massachusetts Agr. Exp. Sta. **25**: 41–44. Ja 1913.

Currant rust, white pine blister rust.

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Thom, C., & Currie, J. N. The dominance of Roquefort mould in cheese. Jour. Biol. Chem. **15**: 249–258. *f. 1.* 2 Au 1913.

Watts, F. *and others.* Report of the Agricultural Department, Dominica **1912–1913**: 1–47. *f. 1–6.* 1913.

Weir, J. R. An epidemic of needle diseases in Idaho and western Montana. Phytopathology **3**: 252, 253. Au 1913.

Wolf, F. A. Black spot of roses. Alabama Agr. Exp. Sta. Bull. 172: 113–118. *pl. 1, 2* + *f. 1–3.* F 1913.

Wolf, F. A. Melanose. Phytopathology **3**: 190, 191. Je 1913.

Wollenweber, H. W. *Ramularia, Mycosphaerella, Nectria, Calonectria.* Eine morphologisch pathologische Studie zur Abgrenzung von pilzgruppen mit cylindrischen und sichelförmigen Konidienformen. Phytopathology **3**: 197–242. *pl. 20–22.* Au 1913.

Includes *Cylindrocarpon* gen. nov. and *Cylindrocarpon cylindroides, Ramularia endidyma,* and *R. olida,* spp. nov.

HENRY WILLEY

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HENRY WILLEY,—A MEMOIR

BRUCE FINK

The subject of our sketch was born July 10, 1824, and died March 15, 1907. He was editor of a local newspaper, *The Standard,* at New Bedford, Massachusetts, from 1856 until 1900. In his vocation, he worked in obscurity. In his avocation, as a student of lichens, however, he was known to the botanists of two continents. Many American botanists are still living for whom he determined lichens a score of years or longer ago. He began the study of lichens about 1862 and continued until within a few years of the time of his death.

Mr. Willey started in a small way by collecting and determining the lichens of New Bedford and vicinity, with the encouragement and aid of Edward Tuckerman. This local work culminated in 1892, after thirty years of collecting and study, in "*An Enumeration of the Lichens Found in New Bedford, Massachusetts, and its Vicinity from 1862 to 1892.*" This publication embodies the results of the best piece of local work ever accomplished on American lichens, and would alone have given its author a place among students of lichens. The list contains nearly 500 species and subspecies, with copious notes. Probably very few of the lichens of the region, however minute or rare, escaped Mr. Willey's notice. Seventeen new species are described.

Mr. Willey's first publication on lichens appeared in 1867, and his last in 1898. Twenty-six papers constitute his contribution to lichen literature. Besides this, six lists of lichens have appeared

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in works by other botanists who gave Mr. Willey due credit for aid on lichens. It is not worth while to discuss each paper separately; but a list of his writings is given at the close of this sketch with explanatory notes on each paper, except in a few instances in which the title indicates content sufficiently well. The six papers which give Mr. Willey credit for work on lichens are appended.

The "*List of North American Lichens,*" which appeared in 1873, was helpful to many students two or three decades ago. This was a paper of 30 pages. Much more important and helpful was a 58-page paper, "*An Introduction to the Study of Lichens with a Supplement,*" which appeared in 1887. Probably every student of American lichens at that time possessed a copy of this work if he could get it. Mr. Willey's "*Synopsis of the Genus Arthonia,*" a 62-page monograph, may be regarded by some botanists as his best contribution to botany; but the writer's judgment is that the local work about New Bedford, culminating in 1892 in the rather short paper already considered above, is the best monument to his patience and skill as a student of lichens. Many botanists look with disfavor upon local floras; but this one is exceptional and represents a life work. On the other hand, Mr. Willey's synopsis of the Arthonias, though its author undoubtedly had an excellent knowledge of the genus, was in the nature of a compilation of existing descriptions and scarcely a critical work.

To Mr. Willey, we must give great credit for editing the second volume of Tuckerman's Synopsis after the death of its author. No one else could have done this important work so well as he who was, after the death of Tuckerman in 1886, the leading student of North American Lichens, and who was also especially fitted for the task by a thorough acquaintance with Tuckerman's methods and work.

Mr. Willey's output in new species was only 26. For his day, when little was known of our lichens, this seems like a small number; but the explanation is that Tuckerman was naming lichens by hundreds, and Mr. Willey's discoveries were named by this greatest American lichenist until his death. So all new species described by Mr. Willey were named after the death of

Tuckerman. The names are given in our list of writings at the close of this paper.

Excepting the Tuckerman herbarium, now at Harvard University, Mr. Willey's herbarium, now in the Smithsonian Institution at Washington, was the largest and most valuable private collection of lichens of his day, if indeed second to any other American lichen herbarium of any time, brought together by one person. The writer has had occasion to consult the Willey collection at Washington and knows personally of its great value. It contains about 10,000 specimens, many of them very rare and valuable.

Mr. Willey belonged to a type of students of lichens now extinct, or nearly so. He was never able to accept even the "dual hypothesis," but believed that the green or the blue-green cells were part of the lichen, just as chloroplasts are parts of higher plants. But some botanists of our day would be quite as much shocked to be told that both this view and the "dual hypothesis" are gone for those who have studied lichens in the light of modern morphology, physiology, mycology and cytology, and that all botanists will some day agree that the lichen is a fungus pure and simple, parasitic on an alga. Again, Mr. Willey, with others of his day, felt certain of the integrity of the group Lichenes. But this group is certain to be distributed generally among other Ascomycetes in the future. The accumulating evidence from the study of life histories of Ascomycetes leaves no alternative. It is not to the discredit of Mr. Willey that he held views very prevalent in his day. He did excellent work on lichens, but every person who studies these plants in our day should seriously consider their nature and proper classification.

Below is given the list of Mr. Willey's papers on lichens.

Willey, H. A fern new to our flora. Am. Nat. 1: 432, 433. 187. The paper also contains notes on 3 common lichens.

Willey, H. American lichenography. Proc. Essex Inst. 5: 191–196. 1867. Gives a fairly good list of publications on American lichens up to 1867.

Willey, H. Lichens under the microscope. Am. Nat. 4: 665–675. *f. 139–153.* 1871. A popular discussion of microscopic structure.

Willey, H. The spores of lichens. Am. Nat. 4: 720–724. 1871. A valuable discussion of the diagnostic value of number and size of spores.

Willey, H. A list of North American lichens. 1–30. New Bedford Mass., published by the author, 1873. A bare list of 808 species and subspecies of lichens. Also 2 genera and 3 species of pseudo-lichens.

Willey, H. Statistics and distribution of North American lichens. Bull. Buffalo Soc. Nat. Sci. 1: 161–167. 1874. Contains valuable information regarding distribution and relation to lichen species of other continents. Also mentions *Opegrapha antiqua* Lesq. (Haydens Report of 1873, p. 370) as the only fossil lichen described from our continent.

Willey, H. Illinois lichens. Bot. Gaz. 2: 77–79. 1877. A list of 113 lichens, followed by a few notes.

Willey, H. Lichens of Southern Illinois. Bot. Gaz. 3: 21, 22. 1878. A list of 61 lichens.

Willey, H. A new North American lichen. Bull. Torr. Club 8: 140, 141. 1881. Describes *Omphalodium hottentottum arizonicum* Tuck., with a general discussion of the species, named by Tuckerman and described by Willey.

Willey, H. Myco-lichens. Bull. Torr. Club 9: 6–8. 1882. A review of Minks' Symbolae Licheno-Mycologicae, and containing a list of 31 North American fungi considered to be lichens by Minks.

Willey, H. Theory of lichens. Bull. Torr. Club 9: 33. 1882. A note regarding the nature of lichens, giving Dr. J. Müller's views as confirmatory of Minks' theory of microgonidia.

Willey, H. *Parmelia furfuracea,* used in embalming. Bull. Torr. Club 9: 152. 1882.

Willey, H. First contribution to the knowledge of Kansas lichens. Bull. Washington Coll. Lab. Hist. 1: 16, 17. 1884. Lists 16 species with notes.

Willey, H. *Gyalecta lamprospora* Nyl. Bull. Torr. Club, 12: 61, 62. 1885. Gives Nylander's description of this new species.

Willey, H. New North American Arthoniae. Bull. Torr Club 12: 113–115. 1885. Gives descriptions of 12 species, but these are reproductions of Nylander's original descriptions in Flora, 1885.

Willey, H. Edward Tuckerman. Bot. Gaz. 11: 73–78. 1886. A sketch of Tuckerman's life, the first two pages of which are not written by Mr. Willey.

Willey, H. Lichens not previously reported from Kansas. Bull. Washburn Coll. Lab. Nat. Hist. 1: 176. 1886. Lists 5 species with notes regarding habitats.

Willey, H. An introduction to the study of lichens with a supplement. 1–58, *pl. 1–10.* New Bedford, E. Anthony & Sons. 1887.

Willey, H. Note on a new North American lichen. Bull. Torr Club 14: 134. 1887. A note on *Buellia catawbensis* Willey, which Nylander in a letter to H. A. Green had previously called *Dermatiscum porcelanum.*

Willey, H. Nylander's Synopsis. I. Bull. Torr. Club 14: 222. 1887. A review.

Willey, H. *Dermatiscum.* Bull. Torr. Club 14: 222. 1887. A note on *Dermatiscum catawbense* (Willey) Nyl.

Willey, H. Lichenotheca universalis. Bull. Torr. Club 14: 247–249. 1887. A review of Lojka's work of that name.

Willey, H. *Trypethelium heterochrous* (Mont.) Tuck. Bull. Torr. Club **15**: 170. 1888. A correction in form of the specific name.

Willey, H. A synopsis of the genus *Arthonia*. I–VII. 1–62. New Bedford, Mass. E. Anthony & Sons, 1890. Gives descriptions of about 350 species of the genus, of which *A. Austinii, A. viridicans, A. perminuta, A. Tuckermaniana, A. microspermella,* and *A. subdiffusa* are described as new from North America.

Willey, H. Enumeration of the lichens found in New Bedford, Mass., and its vicinity from 1862 to 1892. 1–29, 1892; E. Anthony & Sons, New Bedford, Mass. A list of almost 500 species and subspecies with copious notes and new or rare species described. New are: *Pyrenula compacta, Biatora papillariae, B. cladoniscum, B. gyalizella, B. terrena, B. rubidofusca, B. endocyanea, Opegrapha levidensis, O. cinerascens, Mycoporum difforme, Cyridula americana, C. macularis, C. rhoica, C. stigmaea, Coniocybe gracilescens, Verrucaria distans,* and *Pyrenula staurospora.*

Willey, H. Notes on some North American species of *Parmelia*. Bot. Gaz. **21**: 202–206. 1896. Notes on 18 species with the statement that the total number for North America is about 40.

Willey, H. *Parmelia molliuscula*. Rep. Mo. Bot. Gard. **9**: 160. 1898. Reports fruited specimen, collected in Colorado in 1877.

Arthur, J. C., Bailey, L. H., and Holway, E. W. D. Report of botanical work in Minnesota for the year 1886. Bull. Geol. and Nat. Hist. Surv. Minn. 3: 1–56. 1887. A list of 36 lichens determined by Willey and F. L. Sargent, pp. 31 and 32.

Bennett, J. L. Plants of Rhode Island. Providence Franklin Society. I–XIII. 1–128. 1888. Lichens, pp. 20 to 25, 151 species. Revised by Willey.

Coulter, J. M. Botany, Sixth Am. Rep. U. S. Geol. Surv. 747–792. 1873. On pp. 790 to 792 is a list of 67 lichens with notes on habitat and distribution, determined by Willey. There are no new species, but 3 lichens are described briefly without specific names.

Porter, T. C., and Coulter, J. M. Synopsis of the flora of Colorado. U. S. Geol. and Geog. Surv. Territories. Misc. Pub. no. 4: 1–248. 1874. Lichens, pp. 161 to 163, by Willey, 54 species and subspecies. One *Lecanora* and 2 Verrucarias briefly described without specific name.

Rothrock, J. T. List of and notes upon the lichens collected by Dr. T. H. Bean in Alaska and the adjacent region in 1880. Proc. U. S. Nat. Mus. 7: 1–9. 1884. List of 110 lichens with notes on locality, habitat, and structure, the work verified by Willey, who named and described as new *Biatora sibiriensis* from East Siberia.

Wolf, John, and Hall, Elihu. A list of the mosses, liverworts, and lichens of Illinois. Ill. State Lab. Nat. Hist, Bull. 2: 18–35. 1878. The lichens were studied by Willey. See pages 27 to 34 for a list of 216 species and subspecies.

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STUDIES IN NORTH AMERICAN PERONOSPORALES—V.

A REVIEW OF THE GENUS PHYTOPHTHORA[1]

GUY WEST WILSON

(WITH PLATE 119, CONTAINING 5 FIGURES)

Within recent years our knowledge of this genus has been materially augmented by the appearance of a number of important papers. While it is not the present purpose to present a formal review of all these contributions, it seems worth while to make a general survey of the work which has been accomplished to see what advances have been made in our knowledge of this economically very important genus, as well as to take stock, to use a commercial term, with a view of learning what future lines of investigation promise most valuable results. Perhaps nothing has given greater incentive to the study of this genus or made the progress more rapid than the discovery that these fungi could be grown in pure culture. The first contribution to this subject was by Hecke (1898) who grew *P. infestans* on liquid media such as decoctions of plums, tomatoes, cherries, and potato leaves, but was unable to secure a growth on solid media. Later Clinton (1906) discovered that species of this genus could be grown on solid media other than vegetable plugs. Further discussion of this subject, however, is reserved for a later page. In order to best accomplish our object the various species will be taken up separately, reserving general subjects for the later part of the paper.

1. PHYTOPHTHORA PARASITICA Dastur

The most destructive of the few really serious diseases of the castor bean in India is due to this fungus which has been studied in great detail at Pusa (Dastur, 1913). Seedlings are attacked,

[1] Previous papers of this series have appeared in the Bulletin of the Torrey Botanical Club as follows: I. 34: 68–84; II. 34: 387–416; III. 35: 361–365; IV. 35: 543–554. 1907–'08.

causing them to "damp off," while on older plants the leaves suffer most. These are marked with concentrically ringed brown spots. The conidiophores, as is usual in this genus, may emerge either through the stomata or by rupturing the epidermis. The mycelium is both intercellular and intracellular, and often causing a blackening of the vascular bundles. The hyphae are at first quite slender, becoming thicker with age, so that they measure 3–9 μ in diameter. The haustoria are not numerous nor are they differentiated in appearance from young branches. The conidiophores are long and unbranched, usually 100–300 μ tall, but ranging 35–500 μ. The conidia are pyriform, distinctly papillate, 16–60 $\times$ 10–45 μ, and producing from 5 to 45 zoöspores. Intercalary conidia are also found in the cultures which resemble to a considerable extent similar bodies in *Pythium,* but germinating as do the typical conidia. "Varying temperature, alternate light and darkness and moisture are essential factors in the formation" of both conidia and zoöspores. In nature the fungus has been observed to produce conidia sparingly within the tissues of the host, a habit not observed in other species of the genus except *P. infestans.*

Conidial germination, according to the illustrations published, may be either of the typical *Phytophthora* type where each zoöspore escapes separately, or of the *Pythium* type where the entire mass of zoöspores escapes in a vescicle and are later liberated by its rupture. The zoöspores are not different from those of other members of the genus. Chlamydospores are also found in cultures.

The oöspores of this species are formed in the same manner as that described by Pethybridge for *P. erythroseptica.* Indeed the details of sexual reproduction were worked out on these two species simultaneously and independently by Dastur and Pethybridge, each arriving at the same conclusions, although priority of publication made the announcement of Pethybridge precede that of Dastur by several weeks. The most interesting point brought out by Dastur and not by Pethybridge is that the gametes may sometimes arise from the same "stalk" instead of from different ones. When they are on the same hypha the oögonium arises as an ingrowing cell at the base of the antheridium. The

antheridium has reached its full size, or almost so, before the oögonium appears. At the time of the maturity of the oögonium the protoplasm assumes the form of an oöspore and withdraws a little from the thin-walled oögonium, which at the same time becomes thicker walled, and develops a yellowish color. The oögonium measures 18–27 μ in diameter and the oöspores are 15–20 μ, with a thick, smooth, hyaline epispore.

A very interesting portion of the paper is that which deals with the chemical composition of the cell walls, which appears to be the only published account of such studies on a species of *Phytophthora*. It has been stated by previous writers that the cell-walls of the Peronosporales are composed of cellulose only in part, a substance designated callose being present and under certain conditions entirely replacing the cellulose. The tests failed entirely to show the presence of callose in the cell-walls either of the hyphae or the conidia of *P. parasitica*. The only exception to the pure cellulose reaction of the membranes being in the oögonium and oöspore where the inner walls are of a modified cellulose, while the outer walls appear to be of some pectic substance.

The pathogenic nature of the fungus was established by ample experiments. Observations were made which proved conclusively that healthy seedlings planted in the soil in which infected plants had grown within a few weeks past were attacked by the fungus. This is the first time that a species of *Phytophthora* has been positively shown to be able to live in the soil for even a short time although some of them have been strongly suspected of this habit.

Extensive cross-inoculation work with numerous hosts was carried out. Negative results were obtained on cacao, *Cereus, Colocasia, Cleome, Jasminum, Lepidium, Opuntia, Panax, Phaseolus,* and tobacco. Slight or indecisive infections were produced on Areca nuts and lilac. The following were well infected and frequently killed, *Clarkia, Fagopyrum, Gilia, Oenothera, Salpiglossis, Schizanthus, Solanum Melongena, S. Lycopersicum* and *S. tuberosum*. In a field where sesame was grown following castor beans the previous year the stray castor seedlings were attacked by the fungus and later a species of *Phytophthora* indis-

tinguishable from that of the castor bean attacked the sesame seedlings. Reciprocal inoculations proved the two fungi to be identical.

This very interesting fungus is certainly a species of *Phytophthora*, yet its conidial germination, the formation of globose, intercalary conidia, and its ability to live for a time in the soil all point to close relationship to *Pythium*.

2. PHYTOPHTHORA COLOCASIAE Racib.

This species was first described from Java on *Colocasia esculenta* (*C. antiquorum* Schott.) where it is widespread, but not considered of great economic importance. It has since been found in Formosa and over a wide range of teritory in India, where it causes sufficient damage to attract the attention of the workers at Pusa. The results of the studies of Butler and Kulkarni (1913) are highly suggestive of the possible extension of our knowledge of other species of the genus.

On account of the falling of the conidia with a portion of the conidiophore attached after the manner of the pedicel cell of *Basidiophora* and *Kawakamia* the species was transferred by Sawada (1911) to the later genus as *K. Colocasiae*. The fungus is certainly a *Phytophthora*, while *Kawakamia* is more closely related to *Basidiophora*.

Originally described as a leaf parasite, the investigations of Butler and Kulkarni show its activities to be much more widely extended. Not only are the leaf-blades and petioles, and even the inflorescence attacked, but "the parasite commonly reaches the corm and sets up a dry rot during storage," while badly infected plants may even fail to develop corms. This activity is quite suggestive of the tuber-rotting of the potato by *P. infestans*. In this connection it might be remarked that it is not at all impossible that the tuber-rot of *Colocasia* in which was ascribed by Massee to the activities of his *Peronospora trichomata* was in reality due to the attacks of *Phytophthora*.

Detailed studies were made of the fungus both on the host and in pure cultures. The hyphae are quite large (4–9 μ in diameter), with numerous simple, filamentose haustoria. On the aerial parts of the host the fungus is strictly intercellular, except for the

epidermal cells, while in the corm it becomes intracellular, entering both the storage cells and the vascular bundles. The short conidiophores emerge from the stomata. While they are usually simple and bear a single conidium, a second one may be borne in the typical cymose manner of *Phytophthora*. The conidia are quite large ($18–26 \times 30–60\,\mu$ or larger), somewhat pyriform, and more variable both in size and form than in most species of the genus. There is a broad blunt apical papilla.

When mature the conidium "contains a single vacuole of variable size. This is at first irregular and changes shape with the slow movements of the intersporangial protoplasm; then it becomes spherical and ultimately disappears suddenly. The protoplasm itself is at first coarsely granular and after the discharge of the vacuole it is almost homogeneous. About five minutes after the vacuole disappears, the first cleavage lines of the spore-origins become visible and the protoplasm contracts slightly so as to leave a clear space just inside the wall. Soon after, discharge occurs, in the manner so often described for *Phytophthora*, the spores being fully demarcated and provided with cilia before they emerge to the outside." "The zoöspores are more or less bean-shaped, one of the longer sides being convex and the other concave or plane. Each contains a small pulsating vacuole and two cilia arise near together from the concave or plane side, one projecting in front and the other behind while swimming. After swimming for some time they come to rest, round off, lose the cilia and become surrounded by a cellulose wall" (pp. 239–241). A cool temperature facilitates the discharge of the zoöspores. The production of conidia does not appear to be in any way affected by light.

On culture media chlamydospores are common. They vary in size from the diameter of the hypha to $30\,\mu$, and are quite distinct in appearance from the oöspores. As these also occur in *P. Faberi* and *P. parasitica* "it is not impossible that the bodies described as parthenogenic oöspores in several species are really chlamydospores."

Oöspores were produced in various cultures. They are of the same type as is described for *P. erythroseptica* and *P. parasitica*. The oögonia measure $24–35\,\mu$ and the oöspores $20–28\,\mu$. Their germination is unknown.

Infection experiments by Sawada on various species of *Colocasia* and *Alocasia* gave negative results except on forms of *C. antiquorum*. At Pusa infection experiments gave negative results on *Fagopyrum, Jasminum, Lepidium, Nicotiana, Oenothera, Opuntia, Ricinus, Salpiglossis, Schizanthus, Solanun Melongena*, and *Syringa*. A young potato plant showed a definite infection and a wounded tomato seedling gave a very indefinite infection. The only thoroughly successful inoculations were those on seedlings of *Gilia nivale*. The results are not surprising as an extention of hosts would naturally be looked for among the nearer relatives of the host, the Monocotyledons.

3. PHYTOPHTHORA ARECAE (Colem.) Pethyb.

This fungus, which was first described by Coleman (1910) as *P. omnivora Arecae*, is the cause of a very destructive disease of the Areca palm in southeastern India. It attacks the young nuts and the inflorescence covering them with a dense mycelial growth and causing the nuts to drop prematurely. Occasionally the entire tops of the trees are attacked, the hyphae even penetrating the vascular bundles.

The hyphae vary greatly in size up to 8–9 μ in diameter and bear a very few haustoria which are filiform and simple or rarely branched. More commonly there are no haustoria. The conidiophores are distinctly cymosely branched. The conidia vary considerably both in size and shape, measuring $20.6–45.4 \times 30.1–71.0 \mu$. It appears that light is an essential factor both in the production and the germination of the conidia. The zoöspores are about $11.3 \times 8 \mu$, with the anterior cilium measuring 20.7μ in length and the posterior one 29μ. The oöspores have not been observed in nature, but were produced on inoculated nuts in the laboratory. The antheridia and oögonia are described as being borne on separate branches of the same thread, the antheridium, at least in some cases, being formed first. The process of oöspore-formation is said to be similar to that described by De Bary for *P. Omnivora* and by Clinton for *P. Phaseoli*. While it is scarcely credible in the light of our present knowledge of the subject that this species really combines the processes of oöspore formation which are present in the species just mentioned, the

descriptions and figures given by Coleman indicate that this process is of the type which has been described for the two preceding species. The oöspores at maturity measure 23–38 μ in diameter.

Cross innoculation experiments were carried on with a number of plants either known to be hosts of some species of *Phytophthora,* or closely related to some known host. Zoöspores were used in each instance. Inoculations were made both with *P. Arecae* and *P. Faberi.* In addition to areca nuts and cacao pods the list included for both species of fungi members of the following genera; *Cereus, Clarkia, Oenothera, Salpiglossis, Schizanthus* and *Solanum.* "In the case of all the species experimented upon successful infection was accomplished with both fungi with the exception of *Solanum tuberosum.* It seems probable that seedlings of this plant also would be susceptible, but they were not available. In the case of *Solanum melongena* and *Lycopersicum esculentum* only seedlings proved susceptible. Inoculations of plants above 6 inches high were unsuccessful." Of three cacao pods inoculated one showed *Phytophthora* mycelium in the tissues, but did not produce conidia.

4. PHYTOPHTHORA PHASEOLI Thaxter

The first account of the oöspores of this species was given by Clinton (1906) in a paper which must rank as a classic in the literature of this genus as here are first detailed the results of the study of a species of *Phytophthora* in pure culture on agar. The oöspores occur in nature in the diseased pods and seeds of the host. They are smooth, with moderately thick walls, hyaline or light-yellowish in color, and 18–26 μ in diameter. The antheridia are hyaline, ovate to ovoid or irregular shaped bodies, which are usually applied to the base of the oögonium, and measure $8.5\text{–}11.5 \times 14\text{–}17\,\mu$. It appears that "the antheridia are not usually entirely differentiated on the thread until after contact with the oögonium." This, by the way, is quite suggestive of the description given by Blakeslee of the development of the progametes of heterothallic mucors.

In a later paper (Clinton, 1909) a more extended discussion of these phenomena is given. "In the development of the sexual

stage the antheridium is the first to appear, and is often apparently fully developed before there is much evidence of the oögonium. Whether or not the peculiar swellings spoken of earlier develop into antheridia as a result of contact with certain other threads or swellings, it is difficult to determine, but it seems most probable. This potential oögonial thread, with or without a swelling, becomes attached to the base of the antheridium and grows up along its surface toward the apex. Very often it can be seen when it has only partially covered the length of the antheridium. For a long time it was difficult to decide whether or not these threads did not actually penetrate the antheridium and grow through it, and we are not yet certain that this does not sometimes occur. Certainly the optical effect is frequently that of an internal thread with its apical walls very thin as compared with the side walls. In time, however, the oögonial thread reaches the top of the antheridium, and curving around its apex, begins to swell into the oögonium, which by this time is usually cut off from its basal thread by a septum."

To judge from the later work of Pethybridge (1913) and the illustrations from photographs which accompany the later paper by Clinton it appears that what this author really saw and described was the same type of oöspore formation as that recently described by Pethybridge and by Dastur, but that over-caution prevented him from making the proper interpretation of his observations.

5. PHYTOPHTHORA ERYTHROSEPTICA Pethyb.

The announcement by Pethybridge (1913) of this fungus is interesting as adding one more to the already long list of European diseases of the potato as well as including a second species of *Phytophthora* in the list. The fungus is doubly interesting as being the species for which was first described that peculiar method in oöspore formation which we must now consider typical of the genus *Phytophthora*.

So far as mycelial characters are concerned this species is not unlike other members of the genus. The conidia are similar to those of *P. infestans*, but larger and not so prominently papillate, although there is always a well-marked apical region with a

thicker and more transparent cell wall than is found on the remainder of the conidium. The conidia are ovate, or obpyriform due to subapical constriction, and average $20 \times 30\,\mu$. They are also very much crowded on the conidiophores which are not so highly developed as in *P. infestans,* nor are the conidia produced in such great numbers as in that species. Their germination was not noted.

The gametes are produced on separate hyphae, and at first are not well differentiated from other hyphal outgrowths. The antheridium, which is the first to appear, is a rounded or oval structure, borne laterally on the hypha from which it is soon separated by a septum. Sometimes, however, the antheridium is a true intercalary cell. In time the antheridium becomes filled with a very dense mass of granular protoplasm, apparently at the expense of the parent hypha as this becomes empty. The oögonial progamete arises in a similar manner, first appearing as a swollen knob-like body. If it comes in contact with the antheridium it grows in such a manner, as to penetrate it. The duration of this condition and the accompanying cytological phenomena have not been determined, but after a few hours, and apparently only at night, the oögonium bursts out of the antheridium and completes its development. The oögonial wall is usually thinner than that of the antheridium. As the oögonium attains its full size protoplasm ceases to migrate into it and its stalk becomes plugged, although no septum is formed. By this time the parent hypha is almost emptied of protoplasm. During the later stages of the development of the oögonium and just prior to the contraction of the protoplasm and its separation from the wall of the oögonium the contents of the antheridium begin to disappear, but in what manner was undetermined. At maturity the oösphere occupies the upper part of the oögonium, which is composed of the entire protoplasmic contents of the oösphere except small particles which adhere to the oögonial wall. The oösphere now begins to form a wall about itself, which utlimately is about $2\,\mu$ thick, smooth, and yellowish-brown in color. The mature oögonium is about $36\,\mu$ in diameter with a colorless wall which is less brittle than that of *P. infestans*. The oöspores are about $29–30\,\mu$ in diameter, or considerably smaller than those of *P.*

infestans. The method of oöspore formation in this and related species is unique among the Phycomycetes.

In nature the fungus is known only from the peculiar pink-rot of potato tubers which it produces. On solid media like oat agar, potato stalks, bread, and carrots oöspores but no conidia were produced, while the reverse was true in regard to liquid media. Conidia were produced most abundantly on a watery extract of peat soil.

6. PHYTOPHTHORA INFESTANS (Mont.) De Bary

The present species has been a storm center ever since its advent into the scientific world, while its trouble-making possibilities have not yet been exhausted. At first a battle royal waged in western Europe as to the proper name of the species which was then referred to the genus *Botrytis*. So vigorous was this warfare, and so loosely were citations given that anyone who will successfully unravel the tangle in such a way as to effectively and equitably safeguard the honors due each of the contestants, disposing of their claims in a strictly impartial and judicial manner, and arriving at a designation of the species which will meet the requirements of any recognized code of nomenclature, he will have qualified as a real "nomenclatural expert."

The next violent discussion was precipitated by the announcement by Worthington G. Smith of the discovery of the oöspores of the fungus. The results of the ensuing discussion were humorously summarized by Smith who wrote that "the oöspores became a kind of a political subject—oöspores of *P. infestans* or not oöspores of *P. infestans?*" (Clinton, 1911 b). More recently the publications of Clinton and of Jones for a time bid fair to add to the interrogation "and if oöspores, whose?"

In America two names are conspicuously associated with the investigations of the morphology of this fungus. The first note concerning what may now be regarded as probably progametes of this species appeared as an abstract (Jones & Giddings, 1909) of a paper which was not published in full. This was followed in less than a year by the announcement from the same laboratory (Jones, 1909) of the finding of oöspore-like bodies of about 30 μ diameter, but with no evidence of antheridia. These were prob-

ably chlamydospores. A little more than a year elapsed before the announcement by Clinton (1911 a) that "absolutely perfect oögonia, antheridia and even oöspores have been obtained." In the more detailed account of the discovery which appeared in a few weeks (1911 b) the various steps in the development of the oöspore are not so carefully described as were those of *P. Phaseoli,* yet the descriptions of the two species are quite similar. The illustrations which are reproduced from photographs also bear out this statement as some of them show the basal antheridium pierced by the oögonium. While no one has observed an actual fertilization to take place in species of this genius Clinton notes that in case no antheridium were present the development of the oögonium would not pass beyond the differentiation of the oösphere. This certainly precludes the suggestion that the peculiar antheridia of this and other species ot *Phytophthora* are functionless. The oögonia at maturity are 34–50 μ in diameter, with a thick, reddish-brown wall. The oöspores have a medium thick wall which is smooth and hyaline. They measure 24–35 μ in diameter. The experiments which were conducted to determine the factors which govern oöspore formation do not appear to have shed any considerable light on the subject.

The final report of the investigations of Jones and his associates (Jones, Giddings & Lutman, 1912) appeared soon after these papers by Clinton. This paper is a valuable contribution to our knowledge of *P. infestans* in all its aspects. His discussion of the bodies which he terms "resting spores" differs widely from the account given by Clinton. The bodies which are described by Jones are produced in masses large enough to be barely visible to the unaided eye on account of their brown color. "Much variation in structure, grooping, and mode of development of these bodies has been observed, partly due to variations in medium. Most of these bodies have clearly been abnormal developments, or at least have failed to reach normal maturity. Indeed, we doubt if any of them are to be regarded as strictly normal. Nevertheless, it seems worth while to figure and describe the more common or striking features observed" (p. 61). Figures 1 to 20 represent various bodies found in the earlier cultures. These are borne on enlarged hyphae and enclosed in what are interpreted as ex-

cessively gelatinized walls. The solid walls of these bodies are smooth, thick, and brown. Only in a single instance was anything observed which was analogous to the formation of an oösphere. One figure (no. 15) is especially interesting as it is very suggestive of the type of antheridia which have recently been described for several species of *Phytophthora*. It may be that the majority of these bodies are chlamydospores, a structure which is known for several species of the genus.

In the later cultures a very different type of resting spores were found. These are produced, as were the others, either terminally or intercalary, have a single cell-membrane which is thickly covered with spiny tubercles. These resting spores measured 20–33 μ in diameter. The wall has two or three spots which rupture easily and suggest germ pores. The younger stages of these bodies showed 30–50 nuclei. As no bodies corresponding to antheridia were found there is no proof that these bodies are sexual spores, nor is any such claim advanced for them. The exact status of these bodies appears not to have been exactly clear to the authors as the following quotation shows. "These spores have been found in nine different strains of *Phytophthora*. These nine strains were carried continuously in culture for over three years without anything occurring to throw suspicion on their purity. . . . This fact seems to rule out the occurrence of any ordinary type of saprophyte. . . . It is not believed possible that any admixture of saprophytic growth could have entered all cultures alike, much less persist without detection. The only suggestion that seems worthy of further consideration is that these resting spores might belong to a species parasitic upon *Phytophthora* as *Piptocephalis* is upon certain moulds. De Bary, indeed, suggests such a relation as possible between *Artotrogus hydnosporus* and *Pythium debaryanum*. It would seem to us almost impossible, however, that such a condition should occur in all nine cultures alike and persist without detection during so long a period and under such varied cultural conditions" (pp. 68, 69).

These conflicting observations left the question of oöspores of *P. infestans* in a most unsatisfactory condition until the appearance of a paper by Pethybridge and Murphy (1913) which presents evidence of a nature well calculated to set the matter at rest

permanently. These authors describe and figure oöspores similar to those of *P. erythroseptica*, but considerably larger, and agreeing in all respects with those described by Clinton. As the antheridia and oögonia were found to be of the same peculiar type as those of *P. erythroseptica* the authors are led to designate Clinton's "superimposed oögonial thread" as a defective observation of the material in hand. "No spores were observed resembling in any way the resting spores with protuberances on their walls figured by Jones, and recalling *Artotrogus hydnosporus*." According to the observations of these authors when a culture once begins to form sexual organs," it continues to do so in the subsequent transfers without intermission; and although the relative abundance of these bodies may vary somewhat in the successive cultures, as a rule, the subsequent transfers from cultures rich in oögonia, become themselves in due time, also well provided with them." Several transfers covering a period of some fifteen months from the time of isolation appear to have been necessary for the formation of the oösporic habit, while about a week is necessary after making the transfer for the sexual organs to appear in the subculture. It is still an open question as to the conditions under which oöspores occur in nature, if they do so at all. A double oöspore is figured by these authors, and something approaching closely to such a condition is figured by Clinton.

Among the most interesting experiments recorded by Clinton (1911 b: 771–773) are those which concern the attempted hybridization of species. In these the first attempt was made with cultures of *P. infestans* and *P. Phaseoli*, the latter being the more vigorous species of the two and producing oöspores most abundantly. When these species were sown in the same culture "we obtained oögonia, usually only in the vicinity of the *P. infestans* colony, which were entirely different from the normal oögonia of *P. Phaseoli* that were produced abundantly all through the culture. These different *oögonia were of the P. infestans type*, which at that time we were just beginning to get in a small way in our pure cultures of *P. infestans* on oat juice agar, and they differed in that they usually *produced mature oöspores, and were far more abundant than we have ever obtained them in pure cultures of P. infestans*. . . . They also differ, perhaps, in not being so deeply

tinted, and there are some that seem to grade into *P. Phaseoli;* or at least are not very different from that species, as the oögonial walls are only slightly tinted and thickened." These hybrid oöspores were produced from the oögonia of *P. infestans* and the antheridia of *P. Phaseoli,* and measure about the same as the normal oöspores of *P. infestans.* The average measurements of *P. Phaseoli* are 22.5 μ and of *P. infestans* and the hybrids are about 30 μ. The evidence of the hybrid nature of these oöspores appears to be very strong. It would be interesting to know whether they produced fertile hybrids and if so if they are Mendelian or non Mendelian in their behavior.

Hybrids with *P. Cactorum* are also reported but are said to be much more difficult to produce. It is unfortunate that no host of this last species is given, as in the light of recent work on the genus it would be interesting indeed to know what strain of this species was used for the experiments.

Much attention is devoted by Jones to what may be called in a broad sense physiological problems, such as the relation of the fungus to its host, to culture media, to temperature, etc. Much of this data has been published previously and so need not be discussed at present except in a very general way. His observation (p. 28) concerning the production of conidia within the host is apparently the first reference to this habit in the genus *Phytophthora.* The subject of resistant varieties is discussed in considerable detail. "Well-marked and fixed differences exist among potato varieties in relative susceptibility to invasion by *Phytophthora infestans.* . . . These differences occur in foliage as well as in tuber. While foliage and tuber resistance generally go together, this relation is not invariable. The disease resistant quality is resident in large measure, and probably wholly, in the interior tissues of both leaf and tuber. In the tuber it is uniformly distributed throughout the flesh" (p. 83).

In discussing the hosts of this species reference is made to the list given by De Bary which includes "not only a number of other species of Solanaceae grown in gardens, but that he has observed it on one of the exotic species of the Scrophulariaceae, *Schizanthus grahami,* and that Berkeley has described a case where it occurred on another one of the same group, *Anthocercis*

viscosa, from New Holland." At the risk of appearing to be trite we may remark in passing that not only has there been advances made in mycology, but in other fields of botany as well in the past third of a century. Moreover some geographic names have also changed. New Holland is one of these, being labeled on our maps to-day New Guinea. As to the hosts in question both genera appear among the Scrophulariaceae in De Candole's Prodromus while in Engler and Prantl's Pflanzenfamilien they both appear under Solanaceae. In other words De Bary's taxonomy and geography were correct in his own day. This same reference to scrophulariaceous hosts is quoted by Lindau[2] and is given by Clinton as a reason for suspecting the validity of *P. Thalictri.*

Various theories have been advanced as to the means by which the present species maintains itself from year to year, one of them being that the fungus lives over in the soil or in the diseased tubers and débris from the crop. A paper by Stewart (1913) details some experiments on this question. Soil was taken from a field which had produced a crop of blighted potatoes. Diseased and partially decayed tubers and blighted stems were placed in the soil which was subsequently kept outdoors until spring, when it was planted with tubers procured from a blight-free field and treated with disinfectants. No infection occurred, nor could it be induced by painting the leaves with mud prepared from this soil and the diseased potatoes. The author considers his results inconclusive, but indicating that it is highly improbable that the disease persists in the soil over winter.

7. PHYTOPHTHORA THALICTRI Wilson & Davis

The oöspores of this species were found by Clinton (1909: 894) who says that "so far as could be determined, the antheridia and oögonia were developed from different mycelial threads." In the light of present knowledge this would indicate that these organs are of the same nature as those of *P. infestans.* The oögonia are reddish-brown, a little deeper tinted than those of *P. Phaseoli,* moderately thin walled, and measuring 25–33 μ in diameter. The oöspores are hyaline or very light colored, with medium thick,

[2] Sorauer. Pflanzenhr. ed III. 2: 140. 1908.

smooth wall, and measuring 18.5–25 μ in diameter. "Those seen by the writer," says Clinton, "did not differ materially from the oöspores of *P. Phaseoli,* so that we may expect those of *P. infestans,* when found, to be of similar character."

The fungus was not obtained in pure culture. Inoculations were made direct from the diseased leaves to the cut surface of potatoes and onto young tomato plants in the greenhouse. All failed, as did the attempts to produce the fungus on *Thalictrum* by inoculating it with a pure culture of *P. infestans,* which at the same time was able to infect potatoes. Concerning the identity of the present species and the results of his inoculations Clinton says, "since *P. Thalictri* resembles *P. infestans* so closely, the writer has thought that possibly they might not be distinct species. Worthington G. Smith (Diseases of Field and Garden Crops, pp. 275–6) gives a list of different hosts of *P. infestans* which include even two Scrophulariaceae. . . . While these experiments were probably not extended enough to speak positively, still they at least indicate that these fungi are distinct strains, if not distinct species" (p. 895). Personally the present writer regards these experiments as far more conclusive evidence of the distinctness of the two species in question than would the success of any of these inoculations have been of the identity of these fungi. The question which is raised concerning the hosts of *P. infestans* has been noted under that species.

The statement made by Clinton concerning the identity of *P. Thalictri* is misquoted by Dastur (p. 225) who speaks of "*P. Thalictri,* which Clinton suspects to be identical with *P. Phaseoli.*"

8. PHYTOPHTHORA FAGI (Hartig) Hartig

This fungus attacks the beech seedlings in Europe, often proving quite destructive. It first attacks the cotyledons, then spreads to other parts of the plant. A large number of other tree and herb seedlings are known to be subject to the attacks of a *Phytophthora* in Europe and it is not improbable that there is but a single species of the genus concerned in seedling diseases. This, however, has not been investigated in recent years. We are indebted to Himmelbaur for a careful comparative study of this

species and the demonstration of its validity. The results of these studies are discussed under *P. Cactorum.*

9. Phytophthora Cactorum (Lebert & Cohn) Schröt.

This species was originally described from diseased cacti in Europe and was later included along with other forms by De Bary in his *Phytophthora omnivora.*

Comparative studies were made by Himmelbaur (1911) on three forms which might well be included in De Bary's species. They were designated *P. Cactorum, P. Fagi,* and *P. Syringae.* The cultures of *P. Cactorum* were obtained from *Phyllocactus* at Dahlem. As a result of his inoculation experiments with these fungi on three species of cacti he concludes that inoculation experiments are of very little value in delimiting species. However the results of his inoculations, which he presents in tabulated form, are quite interesting so they are quoted in their entirity.

Host	Macroscopic			Microscopic		
	Cactorum	Fagi	Syringae	Cactorum	Fagi	Syringae
Echinopsis Eyriesii	Much affected	Much affected	±Slight infection	Very numerous oöspores	Very numerous oöspores	Numerous oöspores
Cereus tephracanthus	±Slight infection	±Slight infection	Slight infection	Numerous oöspores	Numerous oöspores	Few oöspores
Cereus Martianus	±Slight infection	Slight infection	±Slight infection	Numerous oöspores	Few oöspores	Numerous oöspores

All three forms were grown in Erlenmeyer flasks on sterilized carrots and in Petri dishes on various media. *P. Cactorum* made the most vigorous growth while *P. Syringae* was the weakest. He considers these forms all closely related but morphologically distinguishable both by conidial and oösporic characters as well as by the mycelium. He also expresses the opinion that *Peronospora Sempervivi* Schenk is identical with *Phytophthora Cactorum.* The results of his morphological studies are given in tabular form for ready comparison.

	P. Syringae	*P. Fagi*	*P. Cactorum*
Mycelium:			
Hyphae	slender, regular, intercellular, in culture submerged, apically monopodially much branched.	Slender, regular, intercellular or intracellular, in culture both aerial and submerged, apically scantily monopodially branched.	Very irregular in form, in culture both aerial and submerged, somewhat irregularly branched.
Haustoria	simple or ganglionate and digately branched, cylindric.	Simple or branched, cylindric, or apically enlarged irregularly.	None.
Conidiophores	sympodially branched and thickened below the conidia.	Sympodially much branched and thickened below the conidia.	Not typical sympodial in branching, conidia often borne in clusters.
Conidia	elongate ovate, papillate, apex thick walled, produced tardily, size 40–74 × 30–32 μ.	More or less regularly ovate, papillate, produced abundantly, size 30–40 × 15–30 μ.	Roundish to ovate, very noticeably papillate, very variable in shape and size.
Oöspores:			
Oögonia	globoid, intercallary, seen only in water cultures.	Pyriform, rounded at base, intercallary, seen in water and agar cultures.	Globoid, apical, seen in both water and agar cultures.
Antheridia	borne near the oögonium, tube not seen, relation to oögonium indefinite,	Borne near the oögonium, tube present, applied basally.	Borne near the oögonium, rarely seen in water cultures, applied laterally.
Oöspore	with medium thick, smooth, yellow wall, size 30 μ.	With medium thick, smooth, yellow wall, size 20–30 μ.	With medium thick, smooth, brown wall, size 30–45 μ.

As a result of this comparative study it is very evident that these three forms are distinct species. The next question to present itself is that of the identity of the form which De Bary studied and named *P. omnivora*. From the evidence presented by De Bary in his paper Himmelbaur is inclined to the belief that the form was at least similar to *P. Fagi,* if not identical with it.

In old agar cultures which had begun to degenerate forms appear which are suggestive of *Vaucheria,* from which the author concludes that the genus *Phytophthora* may represent a degenerate state of *Vaucheria*.

The phenomenon of zonation in cultures was studied and the conclusion reached that it is due to variation in temperature.

10. PHYTOPHTHORA SYRINGAE (Klebh.) Klebh.

This fungus has been studied by three investigators who agree as to its morphology. Klebahn (1909) published a comprehen-

sive study of the fungus, including many inoculation experiments to determine its possible host limitations. He was able to secure an abundant infection with the production of oöspores on *Syringa persica, Lygustrum vulgare, Jasminum nudiflorum, Forsythia viridissima* and *Crataegus oxycantha*, while the twigs were killed on *Pirus communis* and *Prunus cerasus* without the formation of oöspores. Indifferent infection was obtained on species of *Acer, Aesculus, Alnus, Corylus, Quercus, Tilia, Pirus, Malus* and *Prunus domestica.* Complete failure was recorded for *Azalia, Betula, Carpinus, Fagus, Fraxinus, Juglans, Philadelphus, Plantanus, Salix, Sorbus, Erica* and *Calluna.* While the infection of the pear would at first sight indicate a possibility of the identity of *P. Syringae* with the species reported on pomaceous fruits, but the failure to infect the apple makes the probability of the identity of the two entirely out of the question.

The morphological characters of the species are included in the summary of the work of Himmelbaur under *P. Cactorum.* The fungus has recently been found in Holland, where it was carefully studied, especially from the standpoint of its economic importance, by Schoevers (1913), whose observations on the morphology of the fungus and its effect upon its host are in accord with the preceding papers. The statement is made that the conidia are unknown in nature. It is, therefore, interesting to note that almost thirty years earlier than any of these papers Berkeley (1881) described a fungus from the leaves of the lilac in Scotland which caused a blackening of the host similar to that caused by *P. infestans* on the foliage of the potato. The opinion was expressed that the two fungi were very closely related, although the lilac inhabiting species was christened *Ovularia Syringae.* In a subsequent paper Smith (1883) described bodies which he termed resting spores from decaying leaves, but his notes are insufficient to indicate the exact nature of the bodies which he found. A third note by the discoverer of the fungus (Wilson, 1886) describes in a somewhat fantastic manner the germination of the conidia by the formation of zoöspores. The fungus appears in Saccardo under Berkeley's name while the only figure cited is that which accompanied the original description. Apparently Saccardo saw nothing in this later sketch to indicate

that the species in question has other relationships than those indicated by its name. Indeed it is a true *Phytophthora* and apparently identical with *P. Syringae*.

The complete synonomy of the fungus then becomes, *Ovularia Syringae* Berk. (1881), *Phleophythora Syringae* Klebh. (1905), *Phytophthora Syringae* (Klebh.) Klebh. (1909). Here is a nomenclatural tangle which is not strictly amenable to the rule of priority. The oldest name of the species is that given it by Berkeley, yet if *Ovularia Syringae* were to be transferred to *Phytophthora* the combination would be untenable as there is already an older *Phytophthora Syringae,* which is based on *Phleophythora Syringae,* a name which is untenable because it is antedated in the synonomy of the species. Perhaps this case comes under the "nomina conservenda" and so will not need to be renamed, but be allowed to carry the specific name which Klebahn gave it.

11. PHYTOPHTHORA NICOTIANAE Van Breda de Haan

Our information concerning this species is derived from the monographic treatment of the species by its author. It is a member of the cactorum group of species, *i. e.,* its antheridium is of the normal type for the Oömycetes. So far it has been recorded only from the East Indies.

13. PHYTOPHTHORA FABERI Maub.

The literature of this species is quite extensive, yet there are a number of points concerning its life history which are far from clear. In the earlier papers the species is referred to as *P. omnivora* De Bary. Perhaps the first careful morphological study of the fungus was that of von Faber (1910) who obtained his material from Kamerun on cacao pods. He considers the fungus distinct from *P. omnivora,* but quite similar to that species. He describes the mycelium as being provided with haustoria and being both intercellular and intracellular, in extreme cases penetrating the seeds, but usually confined to the pods. The conidiophores are 150–200 μ high, bearing one or two conidia, which average $25 \times 30 \mu$ or rarely as large as $42 \times 80 \mu$. The

zoöspores are very numerous, as many as twenty issuing from a single conidium. The oöspores were found in abundance, throughout the infected tissue, but no trace of either antheridia or oögonia. As subsequent investigators have also failed to find the gametes it is now usually conceded that these bodies are in reality chlamydospores. The fungus is considered by von Faber to be coextensive in distribution with the cacao, although epidemic outbreaks have been confined to the American tropics, to Ceylon, and to Kamerun. Apparently drawing on von Faber's account of the fungus for his data Maublanc named it *P. Faberi.*

Infection experiments were first reported by Rorer (1910 a, b) who proved that the pod-rot and the canker of cacao are both caused by the same fungus. He gives a detailed study of the pathology of the organism, concluding that the trunks become infected by the migration of the mycelium from the pods through the twigs. This work was confirmed in Ceylon by Petch (1910) who extended his experiments to the fruit-rot and canker of *Hevea.* He demonstrated the identity of these diseases. "On plantations of *Hevea* only 'canker' has not caused very much damage, but on mixed *Hevea* and cacao plantations it is decidedly more serious." The fungus evidently spreads from the one host to the other in the field.

The correctness of the results obtained by Rorer has been questioned by Essed (1912) who was unable to duplicate the work. He suggests that the trees used might have already been infected with the true cause of the canker, which he considers to be some species of *Lasidiplodia, Nectria* or *Spicaria,* or some other related form. He asks "Why should Mr. Rorer obtain results different from mine? Was it due to the difference between his mode of operation and mine? To be sure, he operated with full grown trees and I did so with seedlings; his trees were standing in the open field and my seedlings were raised and kept under rigorously sterile conditions." The statement of the case by Essed may contain the answer to his inquiry. It is well known that certain fungi attacking mature hosts will not attack the juvenile stage of the same host plant. The reverse is also true. Moreover the "rigorously sterile conditions" under which these experiments were made might have been so thorough that *Phytophthora* could not grow.

Further studies of the species were made by Coleman (1910), who found that in water cultures the conidiophores often bore as many as twenty conidia. Chlamydospores were produced in his cultures in abundance, but oöspores were absent. Extensive infection experiments were carried on in connection with those on *P. Arecae,* under which species they are detailed. In addition the cacao fungus was inoculated onto Areca nuts, obtaining a slight infection in one instance. He named the fungus *P. Theobromae* giving as its hosts, on the authority of Petch, *Theobroma Cacao, Hevea brasiliensis* and *Artocarpus incisa.* In a postscript to his article he notes that "since the above was written an article by Petch . . . has brought to my attention the fact that the cacao fungus has been already given the name of *Phytophthora Faberi.*" In listing the species of the genus Pethybridge includes *P. Faberi* which is "possibly synonymous with *P. Theobromae.*"

From the fact that this fungus is more destructive in the American tropics than elsewhere it is not impossible that this is its home. This is further borne out by the fact that in the West Indies it attacks a second species of *Theobroma,* while its two chief hosts are American in origin. Indeed the bread-fruit is the only well authenticated host of oriental origin, and on this its occurrence appears to be quite limited.

13. PHYTOPHTHORA OMNIVORA De Bary

All members of the genus *Phytophthora* which were not referable to *P. infestans* were collected together under this name by De Bary. So constituted the species included all those forms of the genus found on seedlings and succulents in Europe. Recent work has shown some of these forms to be morphologically distinct, so that it is now a question as to just how much, if any, of the original mass of material can remain under this name.

Since the time of De Bary various writers have added their mite to increase the confusion until to-day the species as usually recognized is indeed a "waste basket" into which is thrown any unidentified *Phytophthora.* Some of these have recently been removed and given their proper status as species, while others which have been adequately studied by their discoverers have

escaped a fate which might have been theirs had they fallen into other hands. The existing confusion lead Coleman (p. 620) to say that "it would appear that a careful revision of the species *Phytophthora omnivora* is needed and this seems particularly necessary for those fungi from outside of Europe which have been identified as this species." It is, however, today the European forms of the species which are in most need of a careful revision.

From time to time a rot of pome fruits has been noted from Europe and ascribed to this species. It was first reported by Osterwalder (1906) on apples in Switzerland. As inoculations on *Sempervivium tectorum* were successful it was referred to this species. A rot of pears in Belgium was recorded by Marchal (1908) and in Bohemia by Bubák (1910), both of whom also refer the fungus to the present species. More recently Osterwalder (1912 *a*) has added the strawberry to the list of fruits attacked, recording a serious outbreak in Switzerland. The same author (Osterwalder, 1912 *b*) records an attack upon young apple nursery stock in which some varieties had almost all the twigs killed. As these young trees grew adjoining the strawberry patch which was so seriously infected it was presumed that this was the source of infection. In all these cases both conidia and oöspores were produced in abundance. The figures and descriptions indicate that more than one species of *Phytophthora* may be concerned and that in all probability none of these outbreaks were really due to the species which is credited with the damage.

Another European record under the name of this species is also furnished by Osterwalder (1909) who found a *Phytophthora* attacking *Calceolaria*. To judge both by the host and the description this may be referable to *P. Cactorum* as now understood, but further information concerning the fungus on this host is highly desirable.

The nutmeg tree (*Myristica fragrans*) in Java suffers from attacks on its leaves and growing twigs by a fungus which Zimmermann (1907) has identified as "*Phytophthora* spec. (*Ph. omnivora* de Bary?)." The conidia are ovate, prominently papillate, with a portion of the conidiophore adhering as a pedicel, measuring 20–60 × 17–30 μ. The conidiophores are typical of the

genus. No oöspores were found. The pedicel adhering to the conidia suggests a relationship with *P. Colocasiae,* although it is a distinct species, and apparently quite dissimilar to the average run of the oriental species of the genus.

The latest addition to the list of pests referred to this species was first reported by Hori (1907) as attacking ginseng in Japan and in Ohio. Since that time it has been found to be a widespread pest in ginseng beds in the United States. This fungus is certainly incorrectly identified. It is described as having simple conidiophores measuring $95 \times 7\,\mu$ and emerging from the stomata. The conidio are elliptic to ovate, $30–50 \times 50–60\,\mu$, prominently papillate, and having a very short basal pedicel. The oöspores are thick walled, light brown in color, and measuring $26–28\,\mu$.

SPECIES INQUIRENDAE

Three additional members of the genus have found their way into literature, yet are of doubtful standing on account of their improper introduction. Mention is made by Gandara (1909) of a *P. Agaves* Villada on the mayguey in Mexico, but no description or figure is given of the fungus. *P. Jathropiae* Petersen has been distributed by the "Centralstelle für Pilzkulturen" but is as yet undescribed. An unnamed species of *Phytophthora* is mentioned by Möller (1901) as occuring on the "figs imported from Europe to Brazil" and at least locally causing considerable damage in gardens. The liminiform conidia are prominently papillate and measure $38–45 \times 100–200\,\mu$. The conidiophores are $100–200\,\mu$ high. The relationship of the fungus is quite obscure as the only species of the genus with which he appears to have been acquainted is *P. infestans.* The fungus may be an European export, in which case it is probably closely related to the other fruit-rotting forms.

CROSS INOCULATIONS

One of the most interesting results of the work on species of *Phytophthora* in the last four or five years is the peculiar and altogether unexpected outcome of the numerous cross-inoculation experiments. A comparison of the results published by the vari-

ous authors tends to throw decided doubt upon the value of this method of delimiting species in this genus, as practically any species of Spermatophyta which is in nature subject to the attacks of any *Phytophthora* is likely under laboratory conditions to be more or less severely attacked by almost any other species. Indeed some of the hosts recorded for various species of the genus are not known to harbor these fungi in nature. It would appear, then, that the parasitism of *Phytophthora* is of such a low order that it will not admit of their being differentiated into races as are certain of the Uredineae for example.

CULTURE MEDIA

Such a discussion as the present would scarcely be complete without a brief mention of the methods and media employed in the pure culture work discussed above. Some of these media are very simple in their nature, but often serving an important purpose in the life history studies on these fungi. Such media are vegetable plugs of various kinds, decoctions of fruits and even of peaty soil, and in the case of one investigator flies were used in distilled water.

The best success has been obtained from growing these fungi on agar made with grain or leguminous seeds as its chief food base. Of these peas, beans and oats have proven most efficient and satisfactory. Such culture media may be made by the following formula, the various seeds and grains remaining constant. Ground beans 40 grams, agar 15 grams, water 1 liter. Prepare in double boiler, or in the autoclave, filtering through absorbent cotton. In case of oats it is preferable to boil 100 grams of ground oats in a liter of water using a double boiler and cooking the oats for two or three hours. Strain and add the other ingredients and sterilize. Species of *Phytophthora* prefer a slightly acid medium (+ 5 to + 10 Fuller's scale).

Synthetic media have received considerable attention from a number of investigators as such media would give a basis of accurate physiological observations. So far this does not appear to have been over successful. The rather extensive series of experiments conducted by him have led Jones to conclude that

low osmotic pressure is necessary to the proper development of *P. infestans* and that it is "limited to certain combinations of chemicals as sources of carbon, nitrogen, and energy. The only really efficient single carrier of these which was found is asparagin, and the availability of this substance seems to be dependent upon the presence of other chemicals" (pp. 51, 52). His most successful formula is as follows: Potassium phosphate 0.25 gm., potassium chlorid 0.05 gm., potassium nitrate 0.5 gm., magnesium sulphate 0.1 gm., calcium carbonate 0.025 gm., asparagin 0.5 gm., water 1 liter.

In the course of his extensive studies on the germination of the conidia of *P. infestans* in relation to various substrata Garbowski (1913) devoted considerable attention to the subject of synthetic media with the result that he recommends Knop's solution with the addition of glucose (0.2 gm. to 50 c.c.).

TAXONOMIC CONSIDERATIONS

From the discussion of the various species of the genus it is evident that there are two distinct types of sexual organs present in species which have been referred to *Phytophthora*. When De Bary described the oöspore formation in *P. omnivora* his account showed nothing which did not agree with the process as we know it in *Peronospora*. Recent investigations have confirmed this on *P. Fagi, P. Cactorum,* and *P. Syringae,* while the description of *P. Nicotianae* indicates that it belongs to the same group of species. These species have been designated by Pethybridge as the *Cactorum-group*. In *P. Faberi* the sexual reproduction is unknown, while in the remaining species of the genus the sexual organs are of the peculiar type described by Pethybridge and by Dastur. The group of species producing this type of gametes has been called in like manner the *infestans-group*. Here we find a mode of sexual reproduction which is unique among the Phycomycetes. So distinct is this method of oöspore formation that Pethybridge proposes to separate the species which possess it into a new family, calling it *Phytophthoraceae*. While the remaining species are retained in the family *Peronosporaceae* under the generic name *Nozemia*. While the process of oögenesis is so poorly understood at present, yet it is apparent from the peculiar

type of gametes and the complete absence of periplasm in the oögonium that the family *Phytophthoraceae* may perhaps be considered as constituting the order *Phytophthorales*.

The name *Nozemia* for the *Cactorum-group* of species is entirely unnecessary, as one of the species included in this new genus is itself the type of a monotypic genus. When Klebahn first published an account of *P. Syringae* he had only the oöspores which he recognized as belonging to the *Peronosporales*, and in absence of conidia he described the fungus as *Phleophythora Syringae*. As the genus was founded on the sexual phase of a polymorphic fungus certainly there can be no objection to its validity forthcoming from an adherent of the European views on the nomenclature of such fungi. Klebahn's name must, therefore, take the precedence, with the following species: 1. **Phleophythora Syringae** Klebh. (*Phytophthora Syringae* Klebh.), 2. **P. Fagi** (Hartig) n. nom. (*Phytophthora Fagi* Hartig), 3. **P. Cactorum** (Lebert & Cohn) n. nom. (*Peronospora Cactorum* Lebert & Cohn, *Phytophthora Cactorum* Schröter), 4. **P. Nicotianae** (Van Breda de Haan) n. nom. (*Phytophthora Nicotianae* Van Breda de Haan).

P. Faberi on account of its imperfectly known life history cannot be definitely assigned to a genus, so it may well remain as at present placed. As *P. omnivora* is here recognized as an aggregate of undetermined affinity it need be considered no further.

NEW BRUNSWICK,
NEW JERSEY.

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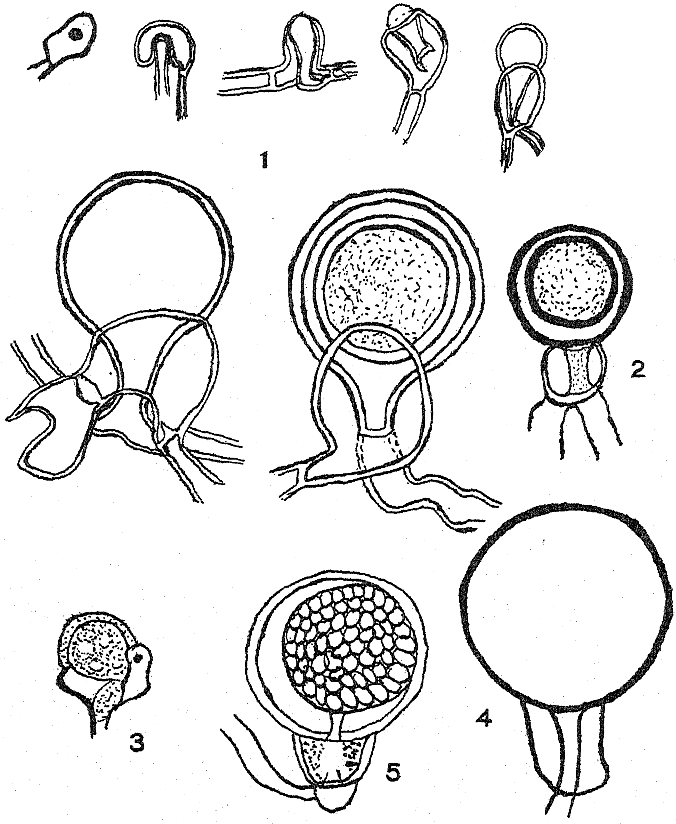

PHYTOPHTHORA

EXPLANATION OF PLATE CXIX

Fig. 1 *Phytophthora parasitica.* Seven stages in oôgenesis. After Dastur.

Fig. 2. *Phytophthora Phaseoli.* Oöspore. After photograph by Clinton.

Fig. 3. *Phytophthora infestans.* Resting spore. After Jones, Giddings, and Lutman.

Fig. 4. *Phytophthora infestans.* Oöspore. After photograph by Clinton.

Fig. 5. *Phytophthora Arecae.* Oöspore. After Coleman.

A PRELIMINARY NOTE ON A NEW BARK DISEASE OF THE WHITE PINE

ARTHUR H. GRAVES

(WITH PLATE 120, CONTAINING 2 FIGURES)

In the spring of 1911, Mr. Herman de Fremery, a student at the Yale Forest School, called the attention of the writer to a disease which appeared to be killing the young white pines in a plantation at the Maltby Lakes, near New Haven, Connecticut.

Soon after this, a trip was made to the region in question. The stand consisted of *Pinus Strobus,* from 5 to 7 feet in height, planted 6 feet apart each way, and just about to commence the ninth year of growth. In one spot, several trees were seen to be entirely dead, forming a blank of considerable area, on the margin of which others were found to be in various stages of the disease.

In cases where the disease had not progressed far, the most apparent outward sign of the trouble was a slight yellowish cast of the foliage, which, from its strong contrast to the normal bluish-green of the healthy trees, could be readily detected from a considerable distance. To all outward appearances, the trunk was sound, but a careful examination showed that the extreme basal portion, which was often more or less covered with old dead leaves and needles, was somewhat sunken and covered with the minute black pustules of some fungus. The bark here was entirely dead, and often at this point the trees were entirely girdled, the lesions extending sometimes 3 or 4 inches from the ground (Plate 120, fig. 2).

At the time, as an effort to determine whether the fungus was a true parasite, four inoculations were made in healthy trees. For this purpose, pieces of bark from the lesions on diseased trees were transferred to corresponding positions at the base of healthy trees where areas of healthy bark of similar size had been cut out. The edges of the patch of diseased bark thus inserted were covered with grafting wax to prevent drying out and contamination.

As far as can be ascertained, these inoculations were unsuccessful, for at the present date, *i. e.*, after the lapse of nearly three years, in three cases the wounds have healed at their edges. Unfortunately, the fourth tree has been lost sight of, but it is of course possible that it was one of the dead trees which have recently been removed from the blank. Since the inoculations were made in the spring of the year, the season may have been unfavorable for the invasion of the fungus, for at this period of its most rapid growth the pine has naturally its greatest capacity for wound healing.

At the present time, the blank caused by the disease in the above mentioned locality is more or less circular, and about 30 feet in diameter. Thirty-one trees have died, and 7 more, here and there around the edge of the area, are dying, each one with the characteristic canker at its base (Plate 120, fig. 1). Of the dead trees, the youngest show eight years' growth, proving that they died in 1910. The disease may therefore have been present at least two or three years before this.

Recently, Professors Toumey and Hawley, of the Yale Forest School, have again directed the writer's attention to the disease. Professor Toumey states that he has recently observed it near Conway Lake, Conway Center, New Hampshire. Here, among wild white pines, he saw several diseased patches, in one or two instances a rod or more in diameter. The trees were all the way from 1 to 10 feet in height, and showed the characteristic constrictions at the base of the stem. Professor Hawley has also noticed the trouble in various plantations in Connecticut. Dr. W. E. Britton, of the Connecticut Agricultural Experiment Station, says that he has seen it, or something very similar, on a plantation near Middletown, Conn. We understand that the same disease has also been reported as occurring in the State of New York.

Dr. G. P. Clinton,[1] in his report of Connecticut plant diseases for 1911–12, notes a trouble which is evidently the same. Speaking of it as a "stem canker," he states that some of the specimens have the aspect of being attacked by a parasitic fungus. He has found a *Phoma* fruiting on the dead area, and thinks that the trouble may be due to this.

[1] Clinton, G. P. Rept. Conn. Agr. Exp. Sta. 1912: 354. *pl. 19a.* 1913.

On account of these various reports and inquiries concerning the disease, the writer has recently taken up its study in detail, one of the principal objects being to determine whether, as Clinton suggests may be the case, it is a trouble following winter or drought injury, or whether it is caused by a parasitic fungus. Connecticut plantations at East Haven, Mt. Carmel, and West Hartford have already been visited, and the disease, with all the symptoms as described above, has been found to be present at these places. Moreover, in all the plantations, blanks like the one described and figured here have been found, and these are being steadily enlarged by the death of trees around their borders.

In 1911, a fungus was isolated from the bark of the dying trees which was believed to be a species of *Fusicoccum*. The work was not followed up, however, and no inoculations with the pure cultures were made. In our recent work, nine fungi have been isolated from the bark of dying trees and several more from the bark of dead trees. Nevertheless, of these nine, the same species of *Fusicoccum* found earlier is of the most general occurrence. The bark of many trees is infested by this species alone, and it is also of importance to note that its fruiting bodies may be found in close proximity to the boundary between healthy and diseased bark. The plurilocular pycnidia, borne in a stroma, contain vast numbers of hyaline, cylindrical spores, usually with one end acute and the other blunt, and averaging $12 \times 2\,\mu$.

The disease resembles the "Einschnürungskrankheit" of the fir, described by Hartig[2] as killing branches of the host, and caused by *Phoma abietina* Hartig, which later became known as *Fusicoccum abietinum* (Hartig) Prill. and Delacr.[3] The spores of this, however, seem to differ in shape somewhat from those of our form.

Pure cultures have been made of all the fungi found on the dying trees, and inoculations with these species on healthy trees in the greenhouse are now in progress. The results of these, together with a more detailed account of the disease, will be published later.

[2] Hartig, Robert. Lehrbuch der Baumkrankheiten, ed. 2. p. 124. 1889.

[3] Prillieux, E., and Delacroix, G. Travaux du Laboratoire de Pathologie végétale, Bull. Soc. Myc. Fr. 6: 176. 1890.

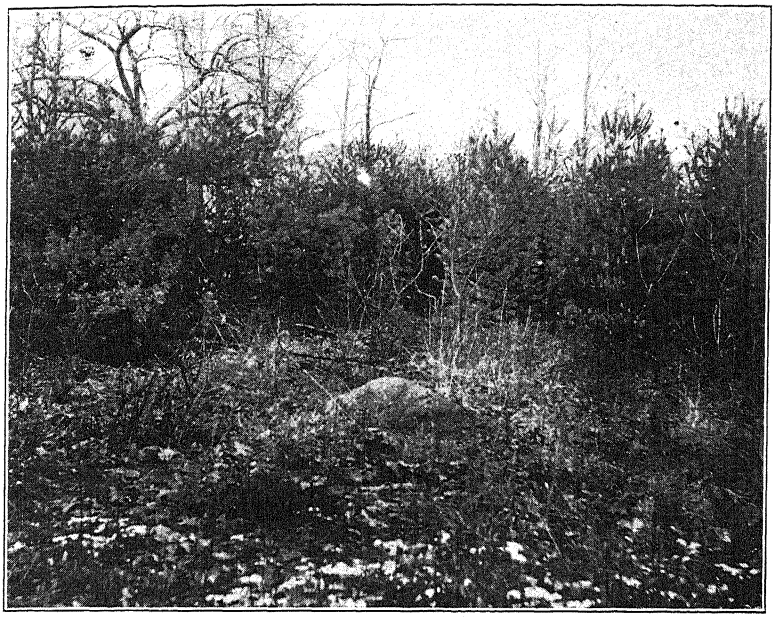

FIG. 1. PLANTATION OF WHITE PINE AFFECTED BY THE DISEASE

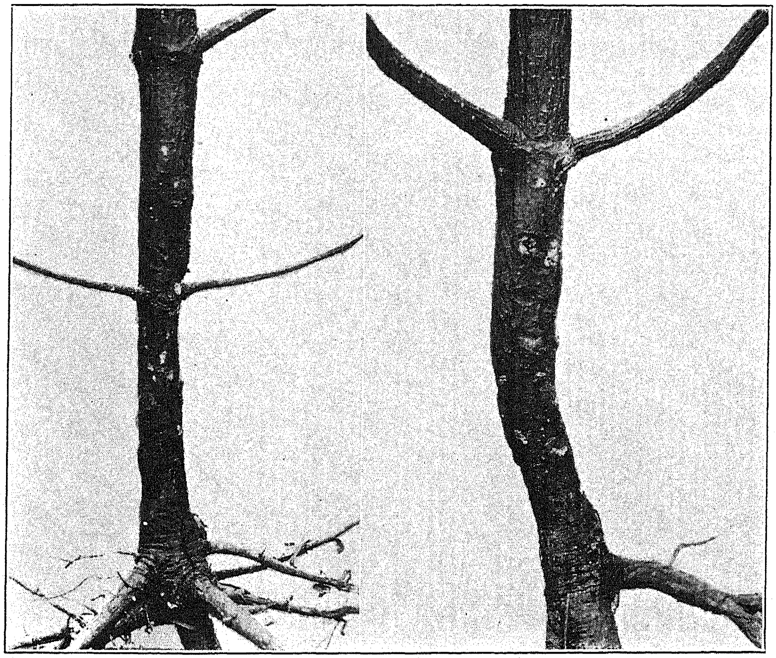

FIG. 2. YOUNG PINE TREES ATTACKED BY THE DISEASE

We take this opportunity, however, to warn owners of white pine plantations to be on the watch for this trouble. Since it is quite probable that it is of a parasitic nature, it is advisable to remove all diseased trees and burn them, or at least the parts of the stem that are affected with the disease, in order to prevent its further spread.

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EXPLANATION OF PLATE CXX

Fig. 1. Photograph showing open area caused by the death of trees from the bark disease in a plantation of *Pinus Strobus* at Maltby Lakes, near New Haven, Conn. At the left, a dying tree, with yellowing leaves, and those of the latest growth much shortened: two trees entirely dead in the foreground at the right.

Fig. 2. Photograph of canker at base of stem of 7 year old *Pinus Strobus*. × 2/5.

NOTES ON A FEW ASHEVILLE FUNGI

H. C. Beardslee

(With Plate 121, Containing 2 Figures)

The occurrence of *Amanita porphyria* Fr. in the United States has been justly considered very doubtful. It has been reported sevaral times, but these reports have seemed open to grave doubts. Lloyd, in his paper on the Volvae, expressed the opinion that it does not occur in this country, and in Mycologia for March, 1913, the same opinion is expressed. In view of this uncertainty, it seems worth while to give the facts upon which my report of its occurrence was based.

In 1905, in company with Mr. Lloyd, I found this species in abundance in Sweden. As is well known, it is quite distinct in appearance, whatever may be thought of its validity as a species. Its brown pileus and the annulus, which forms a peculiar sooty ring on the stipe as the plant matures, at once distinguish it from all its relatives. We learned to recognize it at once.

Two years later, while collecting in Maine, I found what seemed to be the same plant. The pileus was the same color as those we had seen in Sweden and the same sooty ring was formed on the stipe. It was found in spruce woods near Harpswell, under conditions which were closely similar to those in the woods near Stockholm where we had observed it. When compared with Swedish specimens, no difference in microscopic structure could be found. It is, of course, easy to err in identifications of the fleshy fungi, as our literature amply shows, but I feel quite certain of the identity of these plants, especially as the species was already well known to me. I have never seen it in North Carolina. Perhaps, with the station accurately known, its occurrence may later be verified by some collector.

Two other species of *Amanita* mentioned in the March Mycologia may also be worth a brief mention.

Our *Amanita russuloides* belongs to a group of four species which have been described in Europe. *A. junquillea* Quél., *A.*

vernalis Gill., *A. Amici* Gill., and *A. adnata* W. Smith. The first three are French species, the last English. The feeling of many students is that these are all forms of one variable species. Boudier states in a letter that he considers *A. vernalis* and *A. Amici*, both of which he has studied, forms of *A. junquillea.*

Mr. Rea, whose excellent knowledge of the English species is well known, has carefully observed *A. adnata* and finds that the characters which were relied upon in separating *A. adnata* are inconstant. He lists it as a synonym for Quélet's species. It would seem that we need not trouble ourselves unduly in regard to this species.

Our *A. russuloides* is abundant in the southern mountains, where it may be collected all through the summer. At Asheville, the form is a rather better *A. adnata* than the others. It has uniformly no annulus, though farther to the north it seems to have one. I have carefully compared it with specimens from Boudier and have also submitted specimens and photographs to him and to Bresadola. Both agree in considering our plant *A. junquillea.* A comparison of the specimens leads to the same conclusion.

Amanita cothurnata Atkinson will doubtless need further study and comparison before its status is satisfactorily determined. At Asheville, it is one of the most abundant species and also one of the most attractive. Whether it should be considered a form of *A. pantherina* Fries is a question which would be decided partly by our ideas of specific distinction. Bresadola, to whom I judge it was submitted, states that he considers it distinct in its smaller size, white color, and especially its globose spores. Like Murrill, I have never seen typical *A. pantherina* in the United States. I found it common in Sweden and always with the same dark pileus, with which the white warts contrasted finely. At no time did we observe a white specimen. In size, there does not appear to be much difference, though possibly the American plant is on the average smaller. My suspicions as to the validity of our species came from the discovery that the spores are not globose in the fresh plant. A curious change in the spores takes place as specimens are dried. The spores, which are at first ellipsoid, lose their cell contents and become filled with a large globule as described by Atkinson, and at the same time become inflated and

globose. This change has been observed in some other species. With the spores of the fresh plants alike, the most valid grounds of separation seem to be removed. I believe it to be the American expression of *A. pantherina* Fries, though in this conclusion all will doubtless not agree.

If we have not yet arrived at an agreement in regard to the species of *Amanita,* it is not strange that some of our larger and more difficult genera are still more or less confused. The species of *Russula* are so numerous and so difficult of determination that it will be some time before they are all unraveled. At Asheville, this genus is represented by a large number of species. A few of these are of special interest and four of them are discussed here as a slight contribution to the study of this perplexing group.

Russula squalida Peck

This species seems as yet not well understood in the United States. At Asheville, it is extremely variable. Peck describes it as dark-purple, often blackish at the disk. The forms here are so variable in color that they might easily be referred to different species. One form is pale-olive, with the margin almost white, one is a beautiful bright-purple, which approaches lavender, and another closely agrees with Peck's description. It is, however, so marked by such strong characters that it is easy to recognize it in all its disguises. The strong odor, which becomes very pronounced and disagreeable as it dries, distinguishes it at once. The stipe also quickly becomes yellow if it is lightly scraped, and then dark-colored. The fact that the lamellae discolor in drying assists materially in identifying dried specimens.

It seems, however, to have been overlooked that this is a comparatively well known European species. Romell, in his careful study of the Swedish species of *Russula,* distinguishes it, and it was described from his notes as *R. graveolens.* One who had seen Romell's plant under his guidance could not fail to recognize it at once as our own *R. squalida.* It has every characteristic of our American plant. In colors, it agrees well with Peck's description. Maire in his latest work considers it *R. xerampelina* Fr., in part.

RUSSULA MELIOLENS Quélet

This species is common at Asheville and was for several years a puzzle. It is not far from *R. alutacea* and *R. integra,* but is distinct from both. It is not unlikely that it has troubled others who have found it. It is a robust plant, with a peculiar faded red color, mild taste and cream-colored spores. As it dries, it develops a strong odor of new meal, which is very distinct. Its spores are different from those of any species with which it can be confused. They are subglobose and almost smooth. Under an enlargement of 150 diameters, they often seem entirely smooth. A good oil immersion of higher power shows the surface marked with very delicate warts with faint reticulating lines. This is so very unusual in the fragile species of *Russula* that it gives a very accurate means of identification. It is probable that the range of this species will be found to be extensive.

Russula rubescens sp. nov.

Pileus convex, finally expanded and depressed, 5–8 cm. broad; surface red, margin paler, fading with age, thin, striate; context mild to the taste; lamellae rather close, white, adnate, forked, especially at the base; spores pale-yellow, subglobose, 7–9 μ, rough, echinulate; cystidia large, numerous, 50–65 $\times$ 10–12 μ; stipe white, at length becoming cinereous without and within, often blackening with age or in drying, quickly becoming red and then black when wounded, stuffed, becoming hollow.

This species seems especially well marked. The reddening of the stipe when scraped is seen in certain members of the Compactae, but a red species which has this character is a novelty. It suggests in some ways *R. depallens* Fries, which seems to be a puzzle to European mycologists. It is believed by them, however, to be different from that species. As it grows, I find the stipe always becoming blackish within and without at the base.

RUSSULA ALBIDULA Peck

Pileus firm, soon depressed and somewhat infundibuliform, 4–10 cm. broad; surface pure-white, viscid when moist, margin even; context extremely acrid to the taste; lamellae white, becoming yellowish, rather narrow, unequal, decurrent, a few forking;

spores light-yellow, broadly ellipsoid, marked with strong, broken reticulations, 8–9 μ long; stipe pure-white, solid, firm, equal, 4–6 cm. long, 1.5–2 cm. thick.

This is one of the Furcatae. It is closer to *R. sanguinea* than any of the other species, but seems amply distinct from it. It is always pure-white and one of our firmest species as well as one of the most acrid. The spores of *R. sanguinea* are in all my specimens roughly echinulate, which is entirely different from those of this plant, which are adorned with strong raised lines forming a broken reticulation. I find it especially in pine woods during September and October. I have had it under observation for six years and find it remarkably constant.

ASHEVILLE SCHOOL,
ASHEVILLE, N. C.

EXPLANATION OF PLATE CXXI

Fig. 1. *Russula rubescens* Beardslee.
Fig. 2. *Russula albidula* Peck.

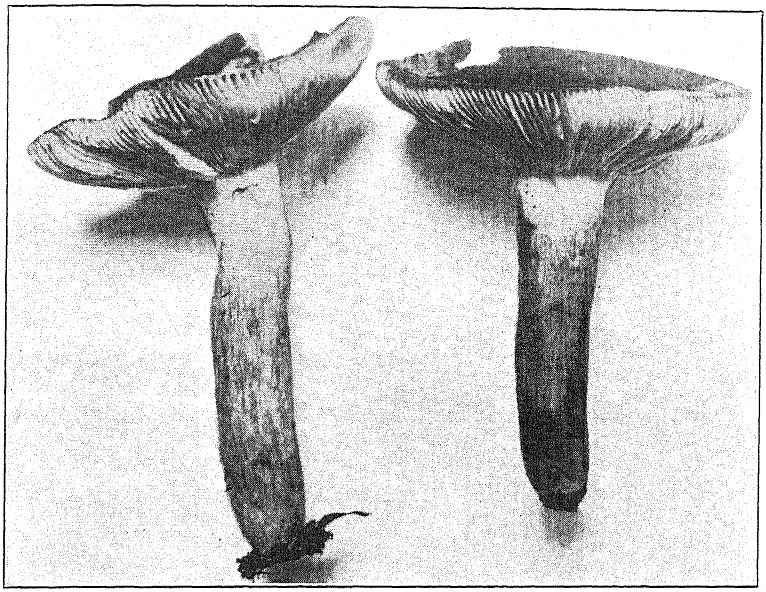

FIG. 1. RUSSULA RUBESCENS BEARDSLEE

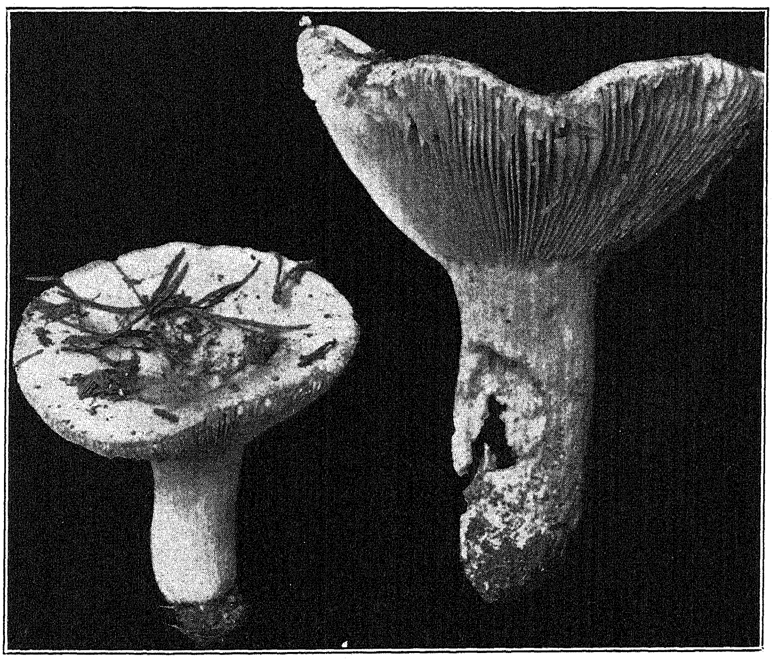

FIG. 2. RUSSULA ALBIDULA PECK

AN ENEMY OF THE WESTERN RED CEDAR

William A. Murrill

(With Plate 122, Containing 2 Figures)

The species described below was first sent to me from Idaho by Mr. Weir. Since the description was drawn, Mr. Weir wrote me under date of December 17, 1913, as follows:

During the past season, the species has been abundantly collected throughout northern Idaho and Washington. It has been found to be of far greater importance in its relation to the decay of the western red cedar than my previous observations showed. Not only is it the principal fungus concerned in the basal decay of the living tree, but it continues the destruction of the heartwood and later of the sapwood after the tree has fallen and may extend along the entire tree, even attacking the bark. The chemical action of the mycelium on the wood results in a separation of the annual layers in the initial stages of decay, later developing a brown, friable rot quite characteristic and easily recognized. The damage caused by the fungus in the western red cedar is great enough to be made a special project for the coming field season.

Fomitiporia Weirii sp. nov.

Broadly effused, often extending many feet along the trunk, irregular, adnate, rather soft, of light weight, flexible when young, 3–10 mm. thick, margin rather thick, adnate or slightly seceding, undulate, lobed, or irregular, broadly sterile, ferruginous to fulvous, velvety-tomentose; context conspicuous, fulvous, punky, soft and flexible; hymenium plane or conformed to the substratum, fulvous-umbrinous, often with an avellaneous tint; tubes indistinctly 2–3 times stratified in older specimens, 2–4 mm. long each season, avellaneous within; mouths angular, stuffed when young, minute, about 6 to a mm., edges thin, entire; spores ellipsoid, smooth, hyaline, $5 \times 3\,\mu$; hyphae ferruginous; cystidia conic, tapering to a sharp point, not ventricose at the base, fulvous, filled with contents, sometimes strongly curved, $35–50 \times$

5–10 μ, the concolorous, tapering stalk often reaching 50 μ in length, but narrower than the projecting portion.

Type collected on a trunk of *Thuya plicata* at Priest River, Idaho, in the Kaniksu National Forest, in 1912, by James R. Weir. Common throughout the northwest, according to Mr. Weir, and confined to *Thuya plicata*. Younger stages would be referred to *Fuscoporia,* and the older stages sometimes have rather the appearance of "reviving" from year to year instead of being truly perennial, as is the case in most species of *Fomitiporia*. For the benefit of those using Saccardo's nomenclature, the species is here recombined as **Poria Weirii** Murrill.

NEW YORK BOTANICAL GARDEN.

EXPLANATION OF PLATE CXXII

Fig. 1. *Fomitiporia Weirii* as it appears normally, and also when reviving and a new layer of tubes is being formed.

Fig. 2. Initial stages in the decay caused by the above species, showing the separation of the annual rings of the host.

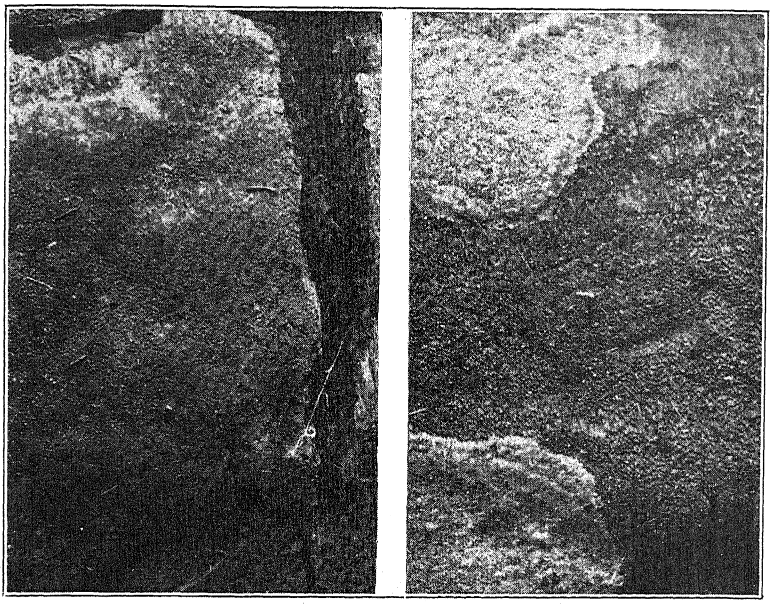

FIG. 1. SPOROPHORE OF FOMITIPORIA WEIRII MURRILL

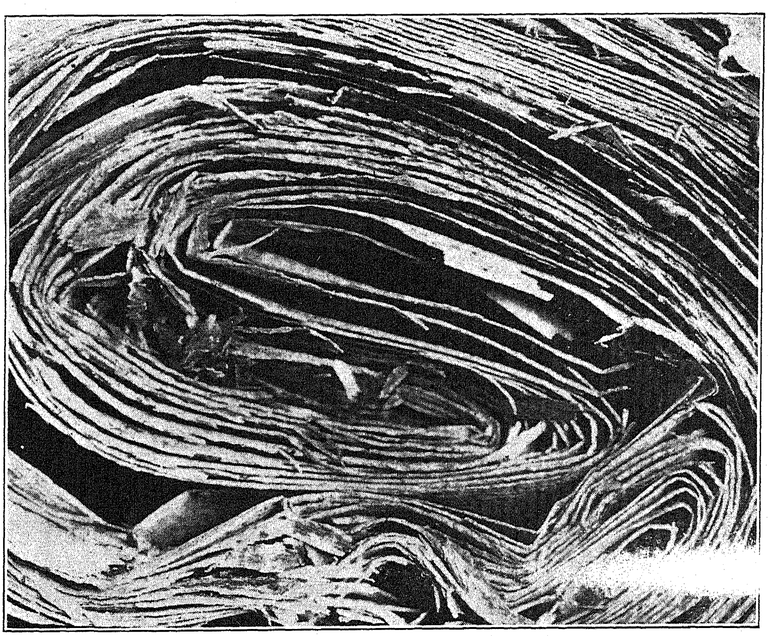

FIG. 2. DECAY CAUSED BY FOMITIPORIA WEIRII MURRILL

NEWS AND NOTES

In the August number of *Phytopathology,* L. L. Harter describes *Plenodomus destruens,* a fungus causing "foot-rot" of sweet potato. A more complete account of the disease appeared in the *Journal of Agricultural Research* for December.

A recent paper by Hauch and Ravn on Oidium in the oak forests of Denmark describes the appearance and effects of the disease, the checking of growth and the lessening of resistance to cold, and suggests potassium sulfid solution as a remedy, but one that is unsuited to forest conditions by reason of the labor and expense involved.

Bulletin No. 355 of Cornell University treats of the apple scab disease, caused by the fungus *Venturia inaequalis* (Cooke) Winter. The paper which is by Errett Wallace contains in addition to a detailed study of the fungus, also a history of the distribution and economic importance of the disease. Also considerable space is devoted to a discussion of the means of controlling it.

In the June number of *Phytopathology,* J. J. Taubenhaus describes *Sclerotium bataticola,* a fungus causing "charcoal-rot" of sweet potato. This was formerly thought to be a state of *Sphaeronema fimbriata* (Ellis & Halst.) Sacc., but it has been proven conclusively by Taubenhaus that it is not. No other fruiting stage could be found for the fungus except the sclerotia, which are produced in large numbers.

Dr. F. D. Heald, of the Laboratory of Forest Pathology, Philadelphia, Pennsylvania, visited the Garden on February 4 and 5 to consult certain types of fungi in the Ellis Collection. He has

discovered some very interesting diseases of trees in connection with his work on the chestnut canker, and the results of his studies will shortly be published.

The January number of the *Journal of Heredity* contains three of the best popular articles yet published on the chestnut canker. Dr. Metcalf gives its history and characteristics, with a strong argument for careful inspection of future importations of nursery stock of all kinds; while Mr. Van Fleet and Dr. Morris tell of immune strains and resistant hybrids that may save the chestnut to horticulture if not to forestry.

The fifth annual meeting of the American Phytopathological Society was held at Atlanta, Georgia, from December 30, 1913, to January 3, 1914. The full program was completed with more than usual dispatch and opportunity was afforded for valuable discussion of the papers, owing to the method recently adopted of preparing a printed abstract of each paper in advance and presenting the papers in the form of abstracts only. As these have been widely distributed among mycologists already, they will not be repeated here.

A box of truffles was sent to the Garden last autumn for our examination, with a note requesting information regarding their food value. Later, the sender of this material made a visit here and stated that the truffles had been collected in the vicinity of New York through the aid of a trained dog imported from Italy. The specimens were filed away in the herbarium for later study. In November, a second package of these fungi was received which was said to have been collected in New Jersey. A microscopic examination of these plants showed them to be two different species. Later, a third collection of the plants was sent for examination, which collection was found to contain some examples of both of the species previously sent. These plants were of especial interest to us since they represent the only two specimens of the genus *Tuber* in our collection from America.

Three species of *Tuber* have been previously reported from the eastern United States, none of which accord well, so far as we can judge from the published accounts, with the two recently collected. The identity of the two recent collections has not been determined with certainty, but the specimens are kept for further study. The indications are that this genus may be well represented in the eastern United States.

In his work on underground fungi occurring in California, Harkness reports thirteen species of *Tuber,* but all of them are so rare as to be of little economic value. Harkness did not find any of the species of truffles usually eaten in Italy, but *Tuber californica* approaches very nearly to one of these Italian species. In addition to *Tuber,* a number of other genera of underground fungi contain edible species.

AGARICUS MUCIFER Berk. & Mont.

While examining recently the type specimens of fungi collected by Sullivant in Ohio and now preserved in the Montagne herbarium in Paris, I made a special effort to connect *Agaricus (Tricholoma) mucifer* Berk. & Mont. Syll. Crypt. 99. 1856 with some species of the genus at present known. The description of the species is as follows:

Pileus fleshy, convex to expanded, center depressed, 12 cm. broad; surface reddish-alutaceous, very viscid, glabrous; flesh incarnate or rosy; lamellae emarginate-decurrent, subconcolorous, white, red-spotted, changing to reddish on drying; spores oblong, apiculate, white; stipe stout, short, bulbous, fibrillose-striate, rufobadious, solid, 6 cm. long, 2 cm. thick at the apex, 3 cm. thick at the base; veil white, fibrillose, joined to margin of young pileus.

This description applies to a plant near *Tricholoma transmutans* or *Tricholoma Russula.* The type specimens are rather confusing. One packet, marked No. 274, has Sullivant's original number tied to the specimens. In this packet, there are two plants, one with bulbous stipe and purplish-red surface, which is evidently the type and is very near *Tricholoma Russula,* the other plant practically white and evidently Montagne's *Clitocybe*

leiphaemia, also collected by Sullivant in Ohio. The spores of the typical specimens are ovoid to ellipsoid, pointed at one end, smooth, hyaline, granular, $6–7 \times 3–4\,\mu$.

Another packet bearing the same number and named *A. mucifer* by Montagne contains still another species. There are in it two old and insect-eaten specimens with slender stipe, thin, crowded lamellae, and pale-purple surface, fading toward the margin. They resemble *Tricholoma Russula,* but are thinner and have a much longer stipe. The spores are broadly ellipsoid to globose, smooth, hyaline, granular, $7 \times 6–6.5\,\mu$. It is very evident that Montagne had difficulty in distinguishing species in the dried state and that the various species we have of the group represented by *Tricholoma Russula* and *Tricholoma transmutans* were confusing to him as they are to us. It is highly desirable that fresh specimens of this group be collected and carefully compared with Montagne's description of *A. mucifer.*

W. A. MURRILL.

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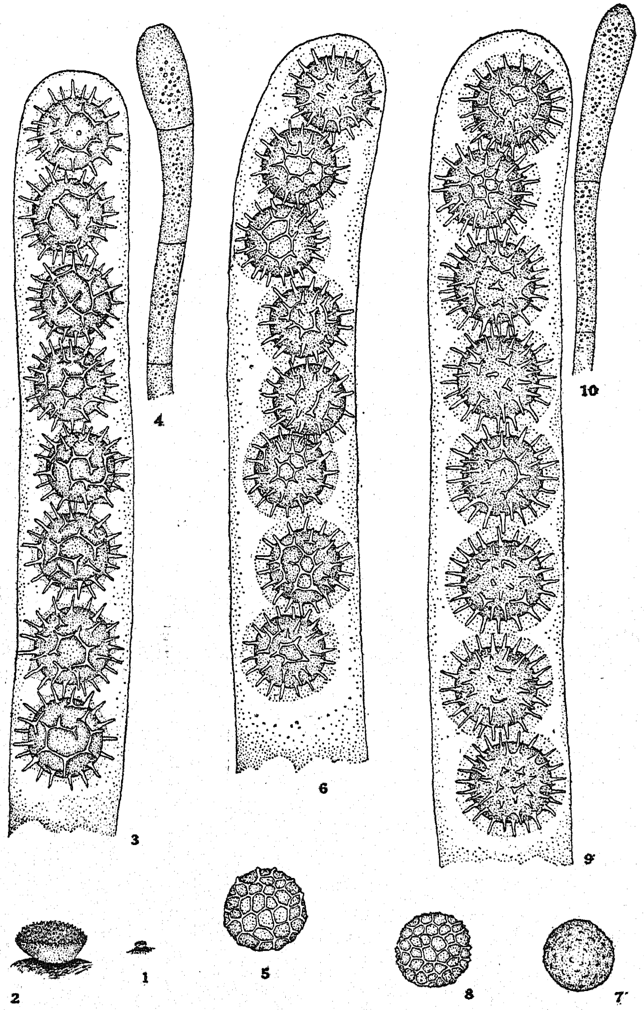

BOUDIERA AREOLATA COOKE & PHILL.
SPHAEROSOMA ECHINULATUM SEAVER

MYCOLOGIA

VOL. VI | MAY, 1914 | NO. 3

OBSERVATIONS ON SPHAEROSOMA AND ALLIED GENERA

FRED. J. SEAVER

(WITH PLATE 123, CONTAINING 10 FIGURES)

In response to a paper recently published on the genus *Lamprospora*,[1] the writer has received from Doctor Roland Thaxter a very interesting plant which it was suggested might belong to that genus, or, possibly, to the genus *Boudiera*. Examination of the spores and paraphyses of this plant, which was collected at Kittery Point, Maine, led the writer to suspect that it was very closely related to *Sphaerosoma echinulatum* of the writer.[2] In fact the spores and paraphyses scarcely differed from those of my own plant. A later examination of the entire plant showed considerable difference in the gross characters of the two, the Maine plant resembling in general appearance a *Lamprospora* rather than a *Sphaerosoma*. In spite of this fact, however, there was sufficient similarity between the two to suggest that they were, at least, very closely related.

The study of this plant has suggested a review of the facts regarding the identity of the genus *Sphaerosoma* and its relation to other genera of the discomycetes. Several papers have recently appeared on this subject, but there are still a number of points which are not entirely clear. Many of these questions will never be cleared up until the species of *Sphaerosoma* are collected in sufficient quantity to make a careful morphological study of the

[1] MYCOLOGIA **6**: 5–24. *pl. 114*. 1914.

[2] Jour. Myc. 11: 2–6. *pl. 75*. 1905.

[MYCOLOGIA for March, 1914 (6: 49–102), was issued March 18, 1914].

genus and its relation to other genera. In the meantime, mycologists will continue to speculate on the probable relationship of *Sphaerosoma* to other genera, as best they can, with the limited knowledge based of the scant material which is available.

The genus *Sphaerosoma* was founded by Klotzsch on *S. fuscescens*. As pointed out by Professor Setchell,[3] there have been various interpretations as to the exact character of the spores of this species, some describing them as echinulate, others as reticulate, and still others as verrucose. Professor Setchell in assuming that the spores in *Sphaerosoma fuscescens* were echinulate has suggested that this type of plant be regarded as the true *Sphaerosoma* and has followed Hennings[4] in treating the reticulate-spored species in the separate genus *Ruhlandiella*. In describing his Californian species, it was therefore placed in the genus *Ruhlandiella* since the spores were reticulate.

The writer has recently examined a specimen of *Sphaerosoma fuscescens* collected in Germany by Klotzsch. While this specimen is not actually marked type, we have reason to believe that it is a part of the type collection. At least, it is probably as authentic as any material that can be had. The spores of this plant are deeply areolate or reticulate, the ridges of the areolae extending two or three microns beyond the periphery of the spore and often appearing as short spines. The spore characters of this plant are very similar to those of *Ruhlandiella hesperia* Setchell, a specimen of the type of this latter species having been examined by the writer through the kindness of Professor Setchell. From the nature of the spores, it is not difficult to account for the description of the spores as both reticulate and echinulate.

It is not even difficult to understand how the spores might have been described as verrucose when we recall that most of the reticulate-spored discomycetes were originally described with verrucose spores. *Peziza Crouani* was so described by Phillips and *Peziza aurantia* has been repeatedly described and illustrated with verrucose spores, although both species have spores which are distinctly reticulate. Even with the microscopes used at the present time, it is often difficult to make out the exact nature of the

[3] Univ. Calif. Pub. 4: 107–118. *pl. 15.* 1910.

[4] Hedwigia 42: (22). 1903.

spore markings in some of these species, and they may even be interpreted differently by different observers. It is possible, however, as suggested by Professor Setchell that Corda[5] had the wrong plant.

Whatever view we accept with reference to Corda's illustration and the accompanying description, the fact remains that Klotzsch's plant examined by the writer shows the spores to be reticulate, and I am therefore compelled to agree with Roupert[6] as to the character of the spores in *Sphaerosoma fuscescens* Klotzsch. Professor Setchell's plant would then according to this view be a true *Sphaerosoma* and rather closely related to the type species.

The suggestion that the Maine plant might be a *Boudiera* and possibly *B. areolata* Cooke & Phill.[7] together with the fact that this eastern plant was found to have spores almost identical with my own *Sphaerosoma echinulatum* from Iowa, has prompted a more thorough investigation of the character of the European *Boudiera areolata.* Fortunately, I have been able to examine a specimen of this species collected in North Wales and which is apparently a part of the type. To my surprise I find that the mature spores of this species are strongly echinulate and so far as I am able to judge identical with Thaxter's plant and my own, although it is possible that the areolae are a little less distinct in the Iowa plant than in the other two. In the original description of *Sphaerosoma echinulatum* the following note was appended referring to the spores: "Microscopic examination shows on the surface in addition to the spines markings which resemble reticulations, but these are short and not continuous and are not seen at the periphery of the spore, so that they are probably only spines bent so as to give this appearance." From this it will be seen that the semi-reticulate character of the spores was noted in the Iowa plants, although possibly misinterpreted. The spores of the three plants examined might be described at maturity as echino-reticulate with a strong emphasis on the "echini." The spores in both the Iowa and the European plant, however, show a variety of changes in the course of their development. The very young spore is smooth later becoming slightly roughened, the roughenings in

[5] Corda, Icones Fung. **6**: 52. *pl. 11, f. 100.* 1854.

[6] Bull. Acad. Sci. Cracovie 1909: 76–95. 1909.

[7] Grevillea **6**: 76. 1877.

the partly matured spore often taking the form of reticulations, the ridges becoming more pronounced about the periphery of the spore until at maturity they appear echinulate with the spines connected by the broken and interrupted ridges mentioned above. The intermediate forms were not seen in the Maine plant for lack of material. All at maturity are pale yellowish-brown.

From the above observations it is evident that we have three plants with spores which are, so far as I am able to determine, identical, *i. e., Boudiera areolata* Cooke & Phill., *Sphaerosoma echinulatum* of the writer and the unnamed plant collected by Dr. Thaxter in Maine. From the gross characters, however, I would not suspect that Dr. Thaxter's plant is the same as my own. The plants in the former are smaller, subturbinate, with the hymenium convex and asci strongly protruding. In the latter the plants are larger, flattened below, with the hymenium forming almost a complete semi-circle and the protruding asci not evident, although it is possible that this latter character might have been overlooked in the Iowa plants. When we take into consideration the fact that only five plants were collected in Maine and several hundred in Iowa, it is possible that these apparent differences in gross characters might fade out if the eastern plant could be collected in larger quantity.

Dr. Thaxter's plants accord more closely with early illustrations of *Boudiera areolata* Cooke & Phill. than do my own. However, after studying part of the type of *B. areolata* the writer is convinced that *Sphaerosoma echinulatum* is only an American form of *Boudiera areolata* of European authors. That this is a European species is evident from the fact that the species has been collected twice in Europe since its description from Iowa material, but each time it has been referred to the name given to the American plant with no suggestion that it had been previously described in Europe. The illustration of *Boudiera areolata* by Boudier[8] fits *Sphaerosoma echinulatum* so far as gross characters and color are concerned. The section, however, shows the hymenium as occupying the upper surface only and in this it does not agree with the *S. echinulatum.* This sketch, however, may be diagrammatic.

The habitats of three collections also show a striking similarity. The European plant was originally collected by William Phillips

[8] Boudier, Ic. Myc. *pl. 417.* 1909.

in North Wales and was said to grow on moist ground on the margin of a lake. The habitat of the Maine plant was given by the collector as follows: " It was growing on bare clay mud, where cattle had stamped around a small pond which dries up in midsummer." Dr. Thaxter states that although the original locality has been visited many times since the original collection was made, no more of the plants could be found. My own plants were collected in a pasture at the foot of two small ravines in a depression which is wet a good part of the year. Here cattle had tramped about until the ground was very uneven with standing water in the low places. The plants grew on the bare clayey soil about the margin and on the elevated portions which were very wet. The type locality has been visited only once since the original collection was made in 1904. The latter visit was during the summer of 1912. A special search was made for the plant at this time. The season did not appear to be favorable, but a few immature plants were found, so that I have reason to believe that the species occurs in that locality regularly when the conditions are favorable. At the time of the original collection, two other discomycetes were found growing in company with it, *Ascobolus viridis* and *Lamprospora Crec'hqueraultii*. Both of these plants were found to be present at the time of the last visit.

The genus *Boudiera* was founded by Cooke on *Boudiera areolata*. The genus was placed in the Ascobolaceae apparently on account of the protruding asci, a character which was thought to be restricted to the Ascobolaceae, and in fact one of the characters on which the family is segregated. This character is common to a number of the Pezizaceae, including members of the genus *Lamprospora*, as has been previously noted. The fact that *Boudiera* is often described as having violet spores and is made to include plants of a coprophilous habitat is likely to be misleading, since the type species shows neither of these characters.

If the genus *Boudiera* as represented by the type species is to be retained as a separate genus, it must be regarded as a close relative of *Lamprospora* on the one hand and as showing at least a superficial resemblance to *Sphaerosoma* on the other. Whether this superficial resemblance is an indication of close natural relationship remains to be seen. This resemblance was noted by

Cooke[9] when he stated in referring to *Boudiera,* "in some respects allied also to *Sphaerosoma.*"

Several of the points raised in the present paper are purposely left open with the hope that additional material collected in the field will help to settle some of the questions which are here only suggested.

CONCLUSIONS

The spores of *Sphaerosoma fuscescens* Klotzsch, type of the genus *Sphaerosoma,* are reticulate and not echinulate as concluded by Professor Setchell. *Ruhlandiella hesperia* Setchell is then a true *Sphaerosoma* and closely resembles the type species.

Sphaerosoma echinulatum Seaver is a plant closely resembling *Boudiera areolata* Cooke & Phill. and is probably only an American form of that species and not a true *Sphaerosoma* at all.

Boudiera as represented by *B. areolata* is a genus closely allied to *Lamprospora* on the one hand and showing at least a superficial resemblance to *Sphaerosoma* on the other, a fact which was noted by Cooke, the author of the genus. Whether this resemblance is any indication of natural relationship is a question.

The unnamed plant collected by Dr. Thaxter in Maine, although showing some differences in gross characters, closely resembles in microscopic details *Sphaerosoma echinulatum* of the writer and both are, so far as I can determine, identical in spore characters with *Boudiera areolata* of European authors. Whether the apparent differences in gross characters are of specific importance can be determined only by the collection and study of more abundant field material.

EXPLANATION OF PLATE CXXIII

Spores and paraphyses drawn with the aid of the camera lucida to a common scale and with the same combination of lenses used in drawings of *Lamprospora* spores, MYCOLOGIA **6**: *pl. 114*.

1–4. *Boudiera* sp. from plant collected by Thaxter in Maine, 1, plant about natural size; 2, plant × 7; 3–4, ascus with spores and paraphysis × 450.

5–6. *Boudiera areolata* Cooke & Phill.; 5, partially matured spore; 6, ascus with mature spores × 450. Drawn from material collected in North Wales and apparently a part of the type.

7–10. *Sphaerosoma echinolatum* Seaver; 7, young spore; 8, partially matured spore; 9 and 10, ascus with spores and paraphysis × 450. Drawn from type.

[9] Grevillea **7**: 57. 1878.

NORTH AMERICAN SPECIES OF PERIDERMIUM ON PINE[1]

Joseph Charles Arthur and Frank Dunn Kern

Nearly eight years ago the writers published an article in the *Bulletin of the Torrey Botanical Club*[2] treating of the species of *Peridermium* then known in North America. Since that time much information has accumulated to supplement what was there said and to correct some errors. That article was founded upon meager material for the most part, but all then available, yet it served an important purpose in stimulating observation and in directing attention to the less known forms.

It is now proposed to review that portion of the previous article which related to the forms of *Peridermium* occurring upon the leaves and bark of various species of pine, and to leave the remainder of the article for possible future notice. In thus restricting the work it will be feasible to show some advances that have been made in the last eight years, to discuss the difficulties encountered in limitation and identification of species, and to set forth the more conspicuous problems for the future. To do this much for the pine-inhabiting species will require as much space as can well be granted for a single article, although other genera of gymnospermous hosts bear species of *Peridermium* in equal need of similar presentation.

The first discussion of the American pine-inhabiting forms was by Underwood and Earle[3] in 1896, who ably presented the subject as known at that time. Only three species were recognized from the eastern United States: *Peridermium acicolum* and *P. orientale* both on leaves and *P. cerebrum* on bark. Two species not seen by the authors had been described from western United States: *P. filamentosum* and *P. Harknessii,* both on bark. A species from

[1] Read before the Botanical Society of America, Atlanta meeting, December 31, 1913.

[2] Volume 33, pp. 403–438. 1906.

[3] Underwood, L. M., & Earle, F. S.: Notes on the pine-inhabiting species of *Peridermium*. Bull. Torrey Club 23: 400–405. 1896.

Colorado, *P. Engelmanni,* was erroneously included among western forms, probably because published as on *Pinus Engelmanni,* now referred to the genus *Picea.*

The five recognized species in 1896 had expanded to fifteen species when the present authors published in 1906, seven being on leaves and eight on bark. At the present time all the seven leaf forms seem to be worthy of recognition, one additional species has been described by Long in the meantime, one species has been introduced from Europe, and two forms are to be separated in this paper, making eleven leaf forms altogether. The greatest upheaval and readjustment has taken place among the bark forms. Much reliance was necessarily placed at first on the form of the gall, but later information derived in part from cultures has given better apprehension of the species. The aecial form of the oak *Cronartium, P. cerebrum,* is now made to include the western form, *P. Harknessii,* as well as the three supposed new species of our former paper, *P. fusiforme, P. globosum,* and *P. mexicanum.* The two diverse-appearing forms, *P. filamentosum* and *P. stalactiforme,* have been united with some hesitation. The misuse of the name, *P. pyriforme,* has been rectified, and the aecial form of the currant rust, *P. Strobi,* which has been introduced from Europe since our former paper, has been added. Altogether five species of bark forms are recognized, the same as previously, but differently assorted.

So far as known, fourteen species out of the sixteen included in this paper are native to North America, and of the fourteen only two are also known outside of North America. One of these, *P. Rostrupi,* is common in Europe, and the other, *P. cerebrum,* is common in Japan.

The remaining two species have been introduced from Europe in recent years, and neither of them is yet established. One of them, *P. Strobi,* is of such economic interest that a stubborn fight is being waged against it in this country. The other one, *P. Fischeri,* is only known in one tree nursery in Wisconsin, and was first seen in 1912. It was found on *Pinus sylvestris,* being the first collection of a *Peridermium* on the leaves of this conifer to be found in North America. In the North American Flora (vol. 7, page 94) *P. oblongisporium,* which also occurs on *Pinus*

sylvestris, is mentioned. The occasion of the citation was the appearance of the alternate stage on *Senecio vulgaris* in Rhode Island. But the rust did not become established, and has not been reported since. The aecial form has never been seen in this country.

The three main sources of information which have led to a better understanding of the forms of *Peridermium* on pine are increased collections with field observations, culture work, and microscopic comparison.

The collections in herbaria are remarkably few and imperfect, due doubtless to two main reasons. These forms of rust appear early in the season when not many collectors of rusts are in the field, and consequently even when abundant they are only incidentally represented in sets of specimens. The bark forms for the most part produce large galls, sometimes a foot or more in diameter, and almost invariably cumbrous and troublesome in comparison with most rust specimens. In consequence only a small fragment of the original gall as a rule is taken, and often with scant data. Specimens in the best condition to study must generally be placed in boxes, as fruits and woody fungi are, rather than in mycological packets. Field observations relative to the probable alternate forms are meagre and principally by a few observers in recent years.

Culture work is not so simple and expeditious as with most other groups of rusts. The information obtained in this way is invaluable, and it will never be possible to have definite knowledge of the species until many more cultures are made, than are at present available. Up to the present writing the following is the record of cultures made in North America with the several forms of *Peridermium* on pine, both foliicolous and caulicolous.

Cultures in the field may result in valuable information, and can afterward be substantiated under glass, if necessary. Damp cool weather is most favorable for the work. Sowings from teliosporic material of *Coleosporium* may be made by suspending fresh material over growing pines, more conveniently over low or seedling pines, care being taken that such material does not wilt for some hours, and that the pine leaves have a moist surface, at least during one night. In the case of *Cronartium* the germinat-

RECORD OF THE CULTURES PROVING RELATIONSHIPS BETWEEN THE SPECIES OF PERIDERMIUM AND THEIR ALTERNATE PHASES

Year	Species of *Peridermium* Host of Culture Material	Trial Host Species of *Cronartium* or *Coleosporium*	Investigator Place of Publication
1902	*Per. cerebrum* *Pinus virginiana*	*Quercus coccinea* *Cron. Quercus*	Shear, Jour. Myc. 12: 89–92. 1906.
1904	*Per. Rostrupi* *Pinus rigida*	*Campanula americana* *Col. Campanulae*	Kellerman, Jour. Myc. 11: 32. 1905.
1906	*Per. acicolum* *Pinus rigida*	*Solidago rugosa* *Col. Solidaginis*	Clinton, Rep. Conn. Exp. Sta. for 1906: 320. 1907.
1907	*Per. cerebrum* *Pinus virginiana*	*Quercus velutina* *Cron. Quercus*	Arthur, Jour. Myc. 13: 194. 1907.
1907	*Per. Comptoniae* (“*pyriforme*”) *Pinus sylvestris*	*Comptonia asplenifolia* *Cron. Comptoniae*	Clinton, Rep. Conn. Exp. Sta. for 1097: 380–383. 1908.
1910	*Per. carneum* *Pinus Taeda*	*Vernonia crinita* *Col. Vernoniae*	Arthur, Mycologia 4: 29. 1912.
1912	*Per. filamentosum* (“*stalactiforme*”) *Pinus contorta*	*Castilleja miniata* *Cron. coleosporioides*	Meinecke; Hedgcock, Phytopath. 2: 176. 1912 (further details in letter from Meinecke); also Meinecke, Phytopath. 3: 167. 1913.
1912	*Per. filamentosum* *Pinus* [*scopulorum*]	*Castilleja* sp. *Cron. coleosporioides* (“*filamentosum*”)	Hedgcock, Phytopath. 2: 176–7. 1912.
1912	*Per. Comptoniae* *Pinus sylvestris, P. ponderosa*	*Comptonia asplenifolia* *Cron. Comptoniae*	Spaulding, Phytopath. 3: 62. 1913.
1913	*Per. cerebrum* (“*fusiforme*”) *Pinus Taeda*	*Quercus rubra, Q. Phellos* *Cron. Quercus*	Arthur & Kern, here reported.
1913	*Per. inconspicuum* *Pinus virginiana*	*Coreopsis verticillata* *Col. inconspicuum*	Hedgcock and Long, Phytopath. 3: 250. 1913.
1913	*Per. delicatulum* *Pinus rigida*	*Euthamia graminifolia* *Col. delicatulum*	Hedgcock and Long, Phytopath. 3: 250. 1913.
1913	*Per. Comptoniae* *Pinus ponderosa*	*Comptonia asplenifolia* *Cron. Comptoniae*	Hedgcock; Spaulding in Phytopath. 3: 308. 1913.
1913	*Per. Comptoniae* *Pinus ponderosa, P. sylvestris, P. Taeda, P. austriaca*	*Comptonia asplenifolia* *Cron. Comptoniae*	Spaulding, Phytopath. 3: 308, 309. 1913.

ing teliospores are inserted into a slit in the bark of the pine, care being taken to include as little debris as possible and to keep the surface moist for some hours.

The basidiospores both in *Coleosporium* and *Cronartium* are ready to be shed immediately upon maturity of the telia, which is largely from July to late fall. The earlier maturing telia are likely to give best results. Some indications of success may occasionally be seen after a few weeks, but the aecia are not likely to appear until the following spring.

Reverse cultures may similarly be made by suspending leaves or bark of pine, bearing the aecia, over the suspected alternate host, usually low growing herbs. Such work must largely be done in spring; and the first mature aecia from such cultures may be again used, and provide more viable spores than those gathered in the field. The uredinia that result from aecial infection will probably appear within ten to thirty days, usually on the under side of the leaves.

Herbarium specimens should invariably be saved, both of the material from which sowings are made, and of the resulting spore forms.

In the present stage of knowledge there is needed a large amount of work on the microscopic characters of the collections now in herbaria. It not infrequently happens that two collections having similar gross appearance present well marked microscopic differences. Or it may be that two specimens with dissimilar gross appearance, as *P. cerebrum* and *P. fusiforme,* now known to be one species, have no material microscopic differences, when well studied. A certain amount of variation in all the microscopic characters must be expected, in some species more than in others. The extent of this variation in each species can only be ascertained by extended microscopic study of large numbers of authenticated collections made at different times and places. Although more characters are now utilized than formerly, especially those pertaining to the peridium, and better technique employed, yet it is not likely that all species can be definitely separated by microscopic characters alone. Especially among those species of *Peridermium* which are aecial forms of *Coleosporium,* that is, the foliicolous forms, there is frequently great similarity. But even

in such cases, careful microscopic diagnoses must be held important.

KEY TO THE FOLIICOLOUS SPECIES OF PERIDERMIUM ON PINUS, ALL BEING THE AECIAL STAGE OF SPECIES OF COLEOSPORIUM

Peridia low, fragile, and inconspicuous.	
Peridial cells quadrilateral in face view, 20–29 μ long.	1. *P. delicatulum.*
Peridial cells oblong in face view, 38–55 μ long.	2. *P. inconspicuum.*
Peridia medium-sized, mostly 0.5–1.2 mm. high.	
Peridial cells slightly overlapping, the side walls 3–4 μ thick or less.	
Spores broadly ellipsoid, the wall 2 μ or less thick.	3. *P. Fischeri.*
Spores narrowly oblong, the wall 2 μ or more thick.	4. *P. montanum.*
Peridial cells strongly overlapping, the side walls 5–9 μ thick.	
Spores moderately and uniformly verrucose, the wall uniformly thick.	5. *P. californicum.*
Spores closely verrucose, sometimes with a smooth area, the wall varying in thickness.	6. *P. acicolum.*
Peridia large and firm, mostly 0.7–1.5 mm. high, occasionally up to 2.5 mm.	
Peridial cells rather finely verrucose, spores verrucose with large deciduous papillae.	7. *P. gracile.*
Peridial cells rather coarsely verrucose.	
Peridial cells with side walls moderately thick (4–7 μ).	
Spores evenly and moderately verrucose.	8. *P. intermedium.*
Spores densely verrucose with prominent elongate papillae.	9. *P. Rostrupi.*
Peridial cells with side walls very thick (7–12 μ).	
Spores with walls moderately thick (2.5–3.5 μ).	10. *P. guatemalense.*
Spores with walls thick (3.5–5.5 μ).	11. *P. carneum.*

1. PERIDERMIUM DELICATULUM Arth. & Kern, Bull. Torrey Club 33: 412. 1906

O. Pycnia 0.3–0.4 mm. broad by 0.5–1 mm. long, low-conoidal, 80–100 μ high.

I. Aecia erumpent from longitudinal slits 1–5 mm. long, delicate, scarcely protruding above the ruptured epidermis; peridial cells usually quadrilateral or hexagonal in face view, 16–24 x 20–29 μ, not or only slightly overlapping, the side walls 2–3 μ thick, the inner wall finely and closely verrucose with uniform papillae;

aeciospores ovoid or cuboidal, 19–21 x 21–28 μ, the wall 1.5–2 μ, finely and evenly verrucose.

On *Pinus rigida* Mill., Connecticut (*Clinton*), Maryland (*Hedgcock* & *Long*, see Mycologia 4: 282. 1912), Massachusetts (*E. T. Bartholomew* in Barth. N. Am. Ured. *720*).

On *Pinus* sp., Florida (Holway in Barth. N. Am. Ured. *517*).

Type collected at St. Augustine, Florida, on *Pinus* sp. (doubtfully *P. Taeda*) March 27, 1903, *E. W. D. Holway*.

DISTRIBUTION: Atlantic coast from Massachusetts to Florida. The telial collections range from Maine to Kansas southward to West Virginia and Texas, but have not been found in the southeastern part of the United States.

This species stands apart from the other foliicolous species on pine on account of the short, fragile peridium and the small, quadrilateral peridial cells. *Per. inconspicuum*, since described by Long, has a peridium which resembles this species in being rather short and delicate, but differs in having larger, thicker-walled peridial cells of an oblong shape. The range for the species has been extended northward along the Atlantic coast as far as Massachusetts, but when careful search is made for it, the range will doubtless be found much greater.

Clinton (Rep. Conn. Exp. Sta. for 1912, p. 353) made observations in the field which led him to think that the telial stage of this form occurs on *Euthamia*, and recently confirmatory cultures have been reported by Hedgcock and Long (Phytopath. 3: 250. 1913). The species apparently has distinctive microscopic characters, and is to be called *Coleosporium delicatulum* (Arth. & Kern) Hedg. & Long, Phytopath. *l. c.*

2. PERIDERMIUM INCONSPICUUM Long, Mycologia 4: 283. 1912

O. Pycnia 0.2–0.3 mm. broad by 0.3–0.7 mm. long, low-conoidal, 85–120 μ high.

I. Aecia flattened laterally, 0.3–0.7 mm. long, by 0.3–0.8 mm. high; peridial cells oblong in face view, 19–27 x 38–55 μ, overlapping, the side walls 3–4 μ thick, the inner wall rather finely and closely verrucose with uniform papillae; aeciospores ellipsoid, 16–18 x 22–30 μ, the wall 1.5–2 μ, finely and very closely verrucose.

On *Pinus virginiana* Mill., Maryland (*Charles; Long*, June 16, 1912).

Type collected at Glen Echo, Maryland, on *Pinus virginiana*, May 5, 1907, *Miss V. K. Charles.*

DISTRIBUTION: Atlantic coast in vicinity of type locality. The telial stage is known only from about the same region.

The species resembles *Per. delicatulum* somewhat in gross appearance and in the microscopic anatomy of the spores, but differs, as pointed out in a foregoing paragraph, in the character of the peridial cells. The alternate stage has been established by cultures reported by Hedgcock and Long (Phytopath. **3**: 250. 1913), and occurs on *Coreopsis*. At present it is known on *C. verticillata* and *C. major*. It is now separated from *Coleosporium Helianthi*, with which it was included in the North American Flora (**7**: 93. 1907), under the name *Coleosporium inconspicuum* (Long) Hedg. & Long.

3. PERIDERMIUM FISCHERI Kleb., Zeitschr. Pf.-Kr. **5**: 71. 1895

O. Pycnia not seen.

I. Aecia flattened laterally, 0.5–1.5 mm. long, 0.5 mm. high; peridial cells in face view broadly ellipsoid, slightly overlapping, the inner wall finely verrucose, the outer wall merely punctate; aeciospores broadly ellipsoid, more or less angular, 18–25 x 25–32 μ, the wall thin, up to 2 μ, closely and moderately verrucose.

On *Pinus sylvestris* L., "Evergreen Nursery," Sturgeon Bay, Wisconsin (*Davis,* June 25, 1913).

Type collected in Europe. (The type collection has not been seen, and the data in hand do not enable us to give details.)

In December, 1912, Dr. J. J. Davis transmitted to the junior author a specimen of *Coleosporium* from J. G. Sanders, which was collected by him in a nursery at Sturgeon Bay, Wis., on Sept. 19, 1912. This proved to be *Coleosporium Sonchi-arvensis* (Pers.) Lev., on *Sonchus asper,* and the first collection of the rust for North America.

In June, 1913, Dr. Davis visited the locality where the *Coleosporium* occurred and found aecia "in profusion on *Pinus sylvestris,*" as he wrote in a letter. Material of this collection has been carefully studied, and although it does not agree exactly with the descriptions given by European students, it is here listed, and with some confidence, as no other collection on the leaves of the

Scotch pine has been reported from North America, and as this one was found where telia of the species had been collected. Two other scanty collections were made in the vicinity both on pine seedlings, thought to be *Pinus Banksiana*, which resemble the *Peridermium* on *Pinus sylvestris*, but they are not included for want of sufficient collateral evidence. The history of this discovery is related by Dr. Davis in a recent number of Phytopathology (3: 306. Dec., 1913).

4. PERIDERMIUM MONTANUM Arth. & Kern, Bull. Torrey Club 33: 413. 1906

O. Pycnia 0.3–0.5 mm. broad by 0.5–1 mm. long, low-conoidal, 55–65 μ high.

I. Aecia flattened laterally, 1–1.5 mm. long by 0.5–1 mm. high; peridial cells ovoid to ellipsoid in face view, 23–35 x 45–65 μ, often acutish at one or both ends, slightly overlapping and easily separating, the side walls 3–4 μ thick, the inner wall rather finely verrucose with low papillae of irregular outline; aeciospores oblong to linear-oblong, 16–24 x 32–45 μ, the wall 2–3 μ, closely and rather coarsely verrucose.

On *Pinus Murrayana* Oreg. Com., Montana (*Blankinship, Stuart*); Washington (*Suksdorf 302 & 645*); Alberta (*Holway*); Rocky Mountains, Canada? (*Macoun*).

On *Pinus scopulorum* (Engelm.) Lemm., Montana (*Kelsey*).

Type collected at Rimini, Montana, on *Pinus scopulorum*, June 24, 1889, *F. D. Kelsey*.

DISTRIBUTION: The far northwest, from central Montana westward and northward.

The standing of this species remains unchanged, since its publication. One or two observers have reported finding *Coleosporium Solidaginis* in close proximity to it and have suggested a possible relation but since the specimens referred here differ very materially in microscopic characters from *Per. acicolum* of the eastern states, which is now known to belong to *Coleosporium Solidaginis*, the species is still maintained. A more likely connection would be with *Coleosporium arnicale*, which may possibly occur on more than one species of *Arnica* from the region indicated above.

5. **Peridermium californicum** sp. nov.

O. Pycnia 0.4–0.7 mm. broad by 0.5–1 mm. long, low-conoidal, about 90 μ high.

I. Aecia tongue-shape, 0.7–1.5 mm. long by 0.8–1.2 mm. high; peridial cells ellipsoid in face view, usually rounded at both ends, overlapping, 29–35 x 50–87 μ, the side walls 5–7 μ thick, the inner walls rather coarsely and closely verrucose with slightly irregular papillae; aeciospores broadly ellipsoid, 25–29 x 40–45 μ, the wall 3–4.5 μ, moderately and rather coarsely verrucose.

On *Pinus radiata* Don. (*P. insignis* Dougl.), California (*Holway*).

Type collected at Monterey, California, on *Pinus radiata,* February, 1908, *E. W. D. Holway.*

DISTRIBUTION: Known only from the type locality on the coast of middle California.

The collection here described as a new species has been made, as the date will indicate, since the publication of our first paper. It was at first determined as *Per. montanum* but a more careful study reveals the fact that it differs very markedly in the peridial cells. In this species the peridial cells are longer, thicker-walled, more coarsely verrucose, and more overlapping than in *Per. montanum.* These distinctive morphological characters together with the fact that there are several unattached species of *Coleosporium* in the region where the collection was made seem to be sufficient to warrant its recognition as a new species.

6. PERIDERMIUM ACICOLUM Underw. & Earle, Bull. Torrey Club 23: 400. 1896

O. Pycnia 0.3–0.5 mm. broad by 0.5–0.8 mm. long, low-conoidal, 80–100 μ high.

I. Aecia flattened laterally, 0.5–1 mm. long by 0.6–1.2 mm. high; peridial cells ellipsoid to ovoid in face view, 23–27 x 40–70 μ, overlapping, the side walls 5–9 μ thick, very coarsely and prominently verrucose with closely set papillae of varying size; aeciospores ellipsoid or obovoid, 20–24 x 28–40 μ, the wall closely and coarsely verrucose, with prominent, somewhat deciduous tubercles, sometimes with a smooth spot extending up one side, varying in thickness from 3–4 μ below up to 5–6 μ in the upper part.

On *Pinus pungens* Mill., Pennsylvania (Charter Oak, June 2, 1913, *Orton & Adams*).

On *Pinus rigida* Mill., Connecticut (*Bishop; Clinton,* S. Manchester, June 6, 1906, used for successful cultures on *Solidago* by the collector; *Thom*); Delaware (*Jackson,* Seaford, June 4, 1908); Pennsylvania (*Buckhout; Orton & Adams*); Massachusetts (*E. T. Bartholomew* in Barth. N. Am. Ured. *710; Cummings & Seymour* in Seym. & Earle, Econ., Fungi *223; Underwood 2862*); New Jersey (*Pennypacker* in Ellis & Ev. N. Am. Fungi *2222, Shear*); New York (*Sirrine; Whetzel & Reddick,* Junius Swamps, May 25, 1906, *Reddick,* same locality, June 1, 1907; North Carolina (*Marr*).

Type collected at Sudbury, Massachusetts, on *Pinus rigida,* June 7, 1891, *L. M. Underwood 2862.*

DISTRIBUTION: From Massachusetts and central New York southward to central North Carolina. The telial stage is known on *Solidago Aster,* and allied genera, almost throughout North America, and eventually aecial collections are likely to be taken over a far greater range than here indicated.

The most interesting development in connection with this species is the proof of its relationship to *Coleosporium Solidaginis* furnished by Clinton's cultures. This seems to be the only foliicolous species where the spores show any tendency to a smooth area after the style of the caulicolous species. This feature is not always discernable and was probably over-emphasized in our previous description. The range is here extended to western New York and southward into North Carolina.

The repeating spores of the sporophytic stage enable the species to maintain itself in regions where pines do not occur, as they often are either produced or remain viable throughout the winter, and start infection in spring without intervention of aecia.

7. PERIDERMIUM GRACILE Arth. & Kern, Bull. Torrey Club 33: 417. 1906

O. Pycnia 190–350 μ broad by 0.5–0.75 mm. long, low-conoidal, 60–75 μ high.

I. Aecia flattened laterally, 0.5–1.5 mm. long by 1–1.8 mm. high; peridial cells broadly ellipsoid in face view, 23–29 x 30–45 μ, overlapping, the side walls 4–5 μ thick, the inner wall rather finely and closely verrucose with uniform papillae; aeciospores ellipsoid, 18–

24 x 23–39 μ, the wall 3–3.5 μ thick, closely and evenly verrucose with large deciduous tubercles.

On *Pinus filifolia* Lindley, Oaxaca (*Pringle*); Jalisco (collector unknown).

Type collected in the mountains above Oaxaca, Mexico, on *Pinus filifolia,* May 28, 1894, *C. G. Pringle.*

DISTRIBUTION: Central Mexico; only two collections known.

There is no additional information concerning this species. The name was an unfortunate selection as there was a *Peridermium gracile* of Harkness (Bull. Calif. Acad. Sci. **1**: 36. 1884) on *Sarcobatus* which has been shown by cultures to be the aecial stage of a grass rust (*Puccinia subnitens*).

8. PERIDERMIUM INTERMEDIUM Arth. & Kern, Bull. Torrey Club 33: 416. 1906

O. Pycnia 0.3–0.4 mm. broad by 0.5–0.75 mm. long, low-conoidal, 65–80 μ high.

I. Aecia tongue-shaped, 1.5–3 mm. long by 0.8–1.5 mm. high; peridial cells broadly ellipsoid, 19–34 x 34–50 μ, overlapping, the side walls 4–7 μ thick, the inner wall rather coarsely and closely verrucose with somewhat irregular tubercles; aeciospores ellipsoid, 16–20 x 23–29 μ, the wall 2.5–3.5 μ, evenly and moderately verrucose.

On *Pinus echinata* Mill. (*P. mitis* Michx.), Arkansas (*von Schrenk*); Maryland (*Galloway*); Missouri (*Barlow 1573, Demetrio* in Rab.-Wint. Fungi Eur. *3315a*); North Carolina (*Howe, von Schrenk*).

Type collected at Perryville, Missouri, on *Pinus mitis,* May, 1883, by *C. H. Demetrio* (Rab.-Wint. Fungi Eur. *3315a*).

DISTRIBUTION: From central Missouri and Arkansas to central North Carolina.

No further data concerning the standing or telial connection of this species have come to our attention, and it is here retained in its original form. The North Carolina localities are new.

9. PERIDERMIUM ROSTRUPI Ed. Fischer, Bull. Soc. Bot. France **41**: clxxii. 1894

O. Pycnia 0.2–0.4 mm. broad by 1–2 mm. long, low-conoidal, 90–110 μ high.

I. Aecia tongue-shaped, 1–3 mm. long by 0.7–1.5 mm. high; peridial cells ellipsoid in face view, 19–30 x 35–58 μ, overlapping, the side walls 4–6 μ thick, the inner wall rather coarsely verrucose with slightly irregular and somewhat deciduous tubercles; aeciospores broadly ellipsoid or globoid, 17–22 x 22–31 μ, the wall 2–3.5 μ thick, densely verrucose with prominent elongate papillae.

On *Pinus rigida* Mill., Ohio (*Kellerman,* Sugar Grove, May 17, 1902, May 1902 in Ohio Fungi *104,* May 1903, May 30, 1904; *Werner,* Ironton, May 27, 1892); Maryland (*Norman*); New Jersey (*Martindale,* in the previous paper this specimen was erroneously listed under *Per. acicolum*); North Carolina (*von Schrenk*).

Type collected in Europe, but the original publication gives no details concerning the host, place, date, or collector's name.

DISTRIBUTION: From New Jersey and central Indiana southward to central North Carolina; also in Europe. The telial stage is known over a slightly wider range.

As stated in the previous paper culture work has been done both in Europe and North America showing the relation of this species to *Coleosporium Campanulae.* No additional work has been reported since our last paper.

10. **Peridermium guatemalense** sp. nov.

O. Pycnia 0.4–0.7 mm. broad by 0.5–1.5 mm. long, low-conoidal, 51–77 μ high.

I. Aecia flattened laterally, 1.5–4 mm. long by 1–1.5 mm. high; peridial cells ellipsoid to globoid in face view, 23–26 x 26–71 μ, overlapping, the side walls 8–10 μ thick, the inner wall moderately verrucose with somewhat irregular papillae; aeciospores ellipsoid, 19–23 x 29–35 μ, the wall 2.5–3.5 μ thick, rather coarsely verrucose with irregular tubercles.

On *Pinus filifolia* Lindley, Guatemala (*Kellerman*).

Type collected at Antigua, Depart. Sacatepequez, on *Pinus filifolia,* Feb. 13, 1905, *W. A. Kellerman 4626.*

DISTRIBUTION: Known only from the type locality in central Guatemala.

When the material first came into our hands we were inclined to call it *Per. gracile;* it was even listed in a paper on The Rusts of Guatemala (Kern, Jour. Myc. **13**: 23. 1907) as that species.

The peridial cells, however, have side walls about twice as thick as in that species, and the markings are coarser and more irregular. Inasmuch as there are a number of species of *Coleosporium* in Central America which call for the existence of *Peridermiums*, the separation of this form is made with considerable confidence.

11. PERIDERMIUM CARNEUM (Bosc) Seym. & Earle, Econ. Fungi 550. 1899

Tubercularia carnea Bosc, Ges. Nat. Freunde Berlin Mag. **5**: 88. 1811.

Peridermium oblongisporium Ravenellii Thüm. Mitth. Forstl. Vers. Oest. **2**: 316 (20). 1880.

Peridermium Ravenelii Kleb. Ber. Deutsch. Bot. Ges. **8**^{2}: 69. 1890.

Aecidium Ravenelii Diet. in Engler & Prantl, Pflanzenfam. **1**^{1**}: 78. 1897.

Aecidium carneum Farl. Bibl. Index **1**: 25. 1905.

O. Pycnia 0.4–0.7 mm. broad by 1–1.5 mm. long, low-conoidal, 60–80 μ high.

I. Aecia flattened laterally, large, 1–6 mm. long by 1–2.5 mm. high; peridial cells broadly ellipsoid in face view, 21–39 by 38–61 μ, overlapping, the side walls 7–12 μ thick, the inner wall coarsely and rather closely verrucose with uniform papillae; aeciospores ellipsoid, 21–29 x 26–35 μ, the wall 3.5–5.5 μ thick, closely verrucose with rather large tubercles often appearing deciduous.

On *Pinus Elliotii* Engelm., Florida (*Tracy*, as on "*P. australis*"); Georgia (*O'Gara*); Mississippi (*Earle*, as on "*P. australis*"; *Tracy*, as on "*P. heterophylla*").

On *Pinus palustris* Mill. (*P. australis* Michx.), Florida (*Rolfs; Stevens; Swingle* in Barth. Fungi Columb. *3043*), Louisiana (*Hedgcock*, Forest Path. no. *344*).

On *Pinus Taeda* L., Alabama (*Arthur, Kern & Lloyd; Atkinson*, as on "*P. serotina*"; *Underwood & Earle*); *Florida* (*Burger; Burger & Fawcett; Fawcett; Martin*, Green Cove Springs, Crescent City in Ellis, N. Am. Fungi *1026b*, both as on "*P. australis*"; *Rau* in Rab.-Wint. Fungi Eur. *3315b*, as on "*P. australis*"; *Sturgis* in Seym. & Earle, Econ. Fungi *550* as on "*P. palustris*"; *Underwood*); Georgia (*Ravenel* in Ellis N. Am. Fungi

1026a; Underwood, Toccoa, April 19, 20, and 21, the last in Seym. & Earle, Econ. Fungi *224*); Mississippi (*Arthur & Stretch*); Texas (*Hedgcock,* Forest Path. no. *708*).

Type collected in South Carolina on *Pinus palustris.*

DISTRIBUTION: From central North Carolina to Florida and westward to central Texas. The telial stage on *Vernonia* is common and abundant from the Gulf of Mexico to Massachusetts, Indiana and Kansas, considerably further northward than the aecial stage has been seen.

Since the previous paper several cultures have been made which show the genetic relation between this species and *Coleosporium Vernoniae.* The first cultures were made by the senior writer in the spring of 1910 (see preceding table) with *Peridermium* specimens sent from Florida; supplementing cultures were made the following season with material collected in Mississippi (see Mycologia 4: 57. 1912); and still further cultures with Florida material were made in 1913. The range of the species has been extended northward from South Carolina into North Carolina and southwestward from Mississippi into Texas.

There are several other species of *Coleosporium* common in this range and some of them have been suspected of belonging to aecial forms very much like *Per. carneum* but no positive cultures have ever been made proving such relationships. It may be possible, however, that some of the specimens here listed may be shown later to belong elsewhere. There is a considerable variation in the size and thickness of walls of the spores in these specimens but since in the experimental work both extremes have been cultured on *Vernonia* the present disposition seems the only one at present possible.

KEY TO THE CAULICOLOUS SPECIES OF PERIDERIUM ON PINUS, ALL BEING THE AECIAL STAGE OF SPECIES OF CRONARTIUM

Branch or stem not noticeably swollen, peridia more or less cylindrical, not confluent. 12. *P. filamentosum.*

Branch or stem with slight fusiform enlargement, peridia subhemispherical, rounded or irregular, sometimes confluent.

  Spores pyriform, finely and closely verrucose. 13. *P. pyriforme.*

  Spores ellipsoid or obovate.

    Spores with wall 1.5–2.5 μ thick, moderately verrucose with uniform papillae. 14. *P. Strobi.*

Spores with wall 2.5–4 μ thick, coarsely verrucose with irregular papillae. 15. *P. Comptoniae.*
Branch or stem gradually or abruptly swollen into a gall, peridia more or less tortuous, usually confluent. 16. *P. cerebrum.*

12. PERIDERMIUM FILAMENTOSUM Peck, Bot. Gaz. **7**: 56. 1882

Aecidium filamentosum Farl. Bibl. Index **1**: 44. 1905.

Peridermium stalactiforme Arth. & Kern, Bull. Torrey Club **33**: 419. 1906.

O. Pycnia unknown.

I. Aecia chiefly on branches 6–12 mm. in diameter, not producing noticeable swellings, scattered, solitary, cylindrical or subcompressed, 1–2 mm. in diameter, usually elongated, sometimes up to 6 or 7 mm. high; peridium rupturing laterally, with more or less evident filament-like processes passing through the spore-mass from apex to base of sorus, or when on *Pinus contorta* and its close allies often appearing on larger branches, the sori often irregular, shorter and more nearly hemispherical, the processes extending from the apex and floor of the aecium only a short distance into the spore-mass; aeciospores oblong, obovate-oblong, or ellipsoid, 14–24 x 23–35 μ; wall 2.5–4 μ thick, closely and rather coarsely verrucose, some spores showing a smooth area on one side toward the base.

On *Pinus ponderosa* Dougl., Arizona (*Pringle*).

On *Pinus scopulorum* (Engelm.) Lemm., Colorado (Monte Vista, 1907, *Hedgcock,* as on "*P. ponderosa*"*;* near Mancos, June 6, 1911, *Phillips,* Timber & Forest Dis. Sur. no. *9085,* as on "*P. ponderosa*"*;* Allen's Park, July 5, 1911, *Spangler;* Devil's Head Mountain, *Dakin;* Pikes Peak, June, 1912, *Notestein,* as on "*P. ponderosa,*" used for successful cultures on *Castilleja* by *Hedgcock,* see Phytopath. **2**: 176. 1912).

On *Pinus contorta* Dougl., California (*Long*), Oregon (*Meinecke,* Fort Klamath, May 23, 1912, used for successful cultures on *Castilleja* by the collector).

On *Pinus Jeffreyi* Oreg. Com., Nevada (*Baker 1351*).

On *Pinus Murrayana* Oreg. Com., Washington (*Suksdorf 645,* type of *P. stalactiforme*).

Type collected in Arizona, "on living branches of *Pinus ponderosa,* July, *Pringle*" (the type specimen in the N. Y. State Mu-

seum which we have seen, bears the additional data, Santa Rita Mts., July 13, 1881, *Pringle* no. *32*).

DISTRIBUTION: The Rocky mountains from their eastern limits in Colorado to the eastern slopes of the Coast Range, and north and south from the Canadian to the Mexican boundaries. The telial stage on *Castilleja* is now known from nearly the same range.

This rust, as here represented, consists of two forms somewhat unlike in gross characters and hosts, but agreeing well in microscopical characters and apparently in telial relations. The form listed above on *Pinus ponderosa* is the one on which Peck's name *filamentosum* was based. This form is especially characterized by elongated cylindrical sori and by the presence of longitudinal filaments within the peridium. The specimens on *Pinus scopulorum,* a close ally of *P. ponderosa,* while not possessed of the typical characters in so striking a manner as the original seem to belong here. The fact that none of these specimens seem typical may be due to their state of preservation, all of them being considerably weathered, whereas the original specimen on *P. ponderosa* was collected and preserved in prime condition. It was with one of these semi-typical forms that Hedgcock reports successful cultures on *Castilleja.*

The form on *Pinus contorta* and its two close allies agrees in making noticeable swellings of the branches and in microscopical characters but it differs in having shorter, more nearly hemispherical sori, which are sometimes irregular in outline. It is with material of this sort that Meinecke reports cultures on *Castilleja.* The apparent difference between this *Peridermium* and the one used by Hedgcock in his cultures on *Castilleja* has led the latter to assume (Phytopath. **2**: 176–7) that two entirely independent species exist. Our examination of a number of specimens of *Cronartium* on *Castilleja* in both uredinial and telial stages from all parts of the geographical range has failed to indicate any morphological variations and this has led us to the opinion that we may possibly be dealing with two *Peridermium* races, with certain structural differences, which have the same telial connection. We have, therefore, ventured to place the *Pinus contorta* forms, to which the name *Per. stalactiforme* belongs, under *Per. filamentosum* although it is done with some doubt. Further cul-

tures are needed before any final conclusion can be reached. We are indebted to Messrs. Hedgcock and Meinecke for furnishing for our studies portions of their authentic material.

The structural differences between these two forms, which are partly one of length of the peridium, may not be so essential as might appear at first thought. Ordinary aecia, which usually appear short and cupulate, oftentimes have been known to grow out into a cylindrical shape many times as long as broad. The presence of the distinct filaments seems very remarkable in Peck's type and has never been duplicated in any specimens examined by us although the attenuate projections from floor and dome of the aecium as previously pointed out under *Per. stalactiforme* are homologous. It may be possible that none of the specimens listed under this species, except the type, should be referred to *Per. filamentosum* and that this name should be retained for specimens which bear its characters in an unmistakable manner. An argument against such a disposition, however, is the fact that there is no known species of *Cronartium* which might be a telial connection, in other words, if we keep these two forms separate we have more forms of *Peridermium* than are required to account for the known telial stages.

13. PERIDERMIUM PYRIFORME Peck, Bull. Torrey Club **6**: 13. 1875

Aecidium pyriforme Peck, Farl. Bibl. Index **1**: 78. 1905.
Peridermium Betheli Hedg. & Long, Phytopath. **3**: 251. 1913.

O. Pycnia unknown.

I. Aecia appearing on the branches or often on the trunks, with no or only slight fusiform enlargements, scattered and usually distinct, oval or irregular in outline, sometimes elongate, 1–3 by 1–6 mm. or larger by becoming confluent, peridium not much exserted above the roughened bark, rupturing along the sides and falling away; aeciospores pyriform, oblong-pyriform, or obovate, 19–24 x 32–66 μ, usually acuminate below; wall 2–3 μ thick, rather finely and closely verrucose with low papillae; contents orange-yellow when fresh.

On *Pinus Banksiana* Lamb. (*P. divaricata* Auct.), Wisconsin (Douglas County, July 1907, *Davis*).

On *Pinus Murrayana* Oreg. Com., Colorado (Gatos, July 23,

1906, three miles north of Allen's Park, June 21, 1913, *Bethel*); Alberta (Devil's Lake, Banff, July 5, 1907, *Holway*).

On *Pinus ponderosa* Dougl., British Columbia (*Vernon*, May, 1913, *Brittain*, communicated by *Fraser*).

On *Pinus pungens* Lamb., Pennsylvania (Charter Oak, June 2, 1913, *Orton* & *Adams*).

On *Pinus scopulorum* (Engelm.) Lemm., Colorado (three miles north of Allen's Park, June 21, 1913, *Bethel;* South Dakota (Rockerville, June 1909, *White*).

On *Pinus* spp., New Jersey (Newfield, *Ellis 2040*); Washington (Seattle, 1906, *Bonser 65*).

The type specimen in the State Museum, Albany, N. Y., is labeled "on pine limbs in the spring, Newfield, New Jersey, *J. B. Ellis,* no. *2040.*" In the original publication it states that Mr. Ellis says that the specimen may have been collected in Georgia and placed by accident among the New Jersey specimens, but it is in the original wrapper and there is strong circumstantial evidence that the inscription on the type specimen is correct.

DISTRIBUTION: New Jersey to Colorado and Washington, northward into western Canada. The probable telial stage on *Comandra* has a slightly wider range, extending into eastern Canada, and into California.

The study of some fresh specimens which have very recently (summer, 1913), come into our hands, together with some data accumulated since our previous paper, has resulted in a complete change of opinion regarding the standing of this species, *Per. pyriforme*. In his original description Peck laid emphasis on the form of the spores which he described as "obovate, pyriform, or oblong-pyriform, acuminate below, .0015–.0025 inch long." We had seen the type specimen, which consists of a portion of a branch a little more than a centimetre in diameter and about 4 cm. long, but we had no opportunity to make a microscopic examination of the spores. Never having seen a *Peridermium* with spores such as Peck described, it was only natural that we should assume that there was something wrong about Peck's description. Knowing that peridial cells are sometimes pyriform we came to the conclusion that he probably mistook some of the smaller peridial cells

for spores. With this for an explanation it was possible for us to make his name *pyriforme* apply to a similar looking species common in that range which had ordinary, small, ellipsoid spores. The species to which we made his name apply was the one which has since been culturally connected with *Cronartium Comptoniae.*

Recently when a fresh specimen, collected in British Columbia and communicated to us by W. P. Fraser, with an apparent abundance of spores dropping off in heaps of orange-yellow powder, was examined, we were surprised to find in the first mount only large pyriform bodies. An attempt to regard them as peridial cells not only seemed futile from the first, but was soon rendered impossible by the finding of unmistakable peridial tissue composed of very different cells. An undetermined specimen on a branch of *Pinus Banksiana* collected in Wisconsin in 1907 by J. J. Davis was next thought of. This is an old weathered specimen without any visible sign of peridia but it was remembered that an examination had showed pyriform cells very like the fresh ones then being studied. In both these specimens these pyriform cells had a low verrucose sculpturing very unlike peridial cells, and since their shape and size agreed precisely with Peck's original description the belief that we were dealing here with a characteristic and practically unknown species, except for the obscure type, was gradually forced upon us. Fortunately within a few days some fresh specimens received from Colorado collected by E. Bethel added to our supply of this striking species. These developments gave impetus to the study and we next turned to the herbarium to see if any specimens belonging here might have been placed erroneously, and carelessly, in some other species. Our suspicions were well founded, and we were soon able to add South Dakota, Washington, and Alberta to our list of localities. We were soon able to secure spores from the type specimen in the Museum at Albany, N. Y., which abundantly confirmed Peck's original description, and our recent inferences.

The next problem to present itself was very naturally the question of an alternate phase. According to our new conception we had a *Peridermium* species distributed across the continent from New Jersey to British Columbia with enough intermediate localities to make the distribution continuous throughout the range.

The deduction was soon made that *Cronartium Comandrae* is the probable connection, inasmuch as it is an unassociated form with nearly an identical geographical distribution, *i. e.,* northern United States and southern Canada from ocean to ocean. The fact that it is the only unattached *Cronartium* now known would be enough to strongly suggest the relation, but the complete coincidence of range is a prominent factor in support of the theory. A further bit of evidence is furnished by the field observations of E. W. D. Holway who stated on the packet of his Alberta collection that it was undoubtedly associated with a *Cronartium* on *Comandra.*

Collectors in the eastern states, especially, should be on the lookout for this interesting species. Although apparently very meagerly represented in herbaria from this region it doubtless occurs not infrequently, judging from the numerous collections of the *Cronartium* on *Comandra.*

14. PERIDERMIUM STROBI Kleb. Abh. Nat. Ver. Bremen **10**: 153. 1887

O. Pycnia scattered, honey-yellow, forming minute bladdery swellings; pycniospores hyaline, ovoid or elliptical, 2–4 μ across.

I. Aecia on fusiform swellings of the stem or branches, usually scattered and solitary, rounded or somewhat elongate, 1–1.5 by 2–5 mm., subhemispherical, 1–2 mm. high, rupturing irregularly along the sides; aeciospores broadly ellipsoid or obovoid, 18–24 x 22–27 μ; wall 1.5–2.5 μ thick, moderately verrucose with low uniform papillae, with a smooth area apparent on some spores at the base often extending up one side.

On *Pinus Strobus* L. Introduced from Europe, through nursery stock, into the northeastern Unitel States and Indiana, Ohio, and Ontario, Canada, in 1909 according to Spaulding, Bull. Bur. Pl. Ind. no. 206, 1911.

Type collected in Bürgerpark, Bremen, Germany, on the bark of *Pinus Strobus.* It was first observed in 1886 but the information in the original publication is not definite enough to permit the designation of any particular collection as type.

DISTRIBUTION: Locally introduced with nursery stock from Maryland and Vermont to Illinois and Wisconsin, but believed to have been destroyed in every case; common in Europe.

The rust here described under the name *Per. Strobi* is the one

which has come to be generally known as "the blister rust of white pine," and has been connected by numerous cultures in Europe and America with the *Cronartium* on *Ribes*. The presence of the aecial stage (*Per. Strobi*) in North America has been known only since 1909 when it was imported in nursery stock from Germany and widely distributed, especially in the northeastern states. The rust on the *Ribes* has been known for a somewhat longer period. The first record was a collection of the uredinial stage on *Ribes longiflorum* (reported as *R. aureum*) in Kansas in 1892. Definite observations on a sufficient scale to indicate its establishment in this country date back only to 1906 when Stewart found the uredinial stage in the currant plantation of the Experiment Station at Geneva, N. Y. Since that time it has been reported in various localities. There is no information at hand which is of assistance in explaining the early isolated occurrence in Kansas. Through Mr. W. H. Rankin, of Cornell, we learn that recently (spring, 1913), two white pine trees, about fifteen years old, have been found at Geneva with evidence of old infection of the blister rust.[4] One tree is said to show signs of having been infected when very young and long cankers, almost girdling the trunk, have spread upward from the lower whorl of branches, where infection took place, a distance of about three feet. The fungus was fruiting in abundance this spring (1913) on the newly invaded tissue at the edge of the cankers. The fact that this must have been fruiting several years ago will assist in accounting for the original epidemic at Geneva, as well as for more recent outbreaks there.

The condition which obtains in North America with regard to this species is a peculiar one. The white pine, a native only of this continent, was not originally afflicted with a rust disease but upon being extensively grown from seeds in European nurseries it became subject to this extremely damaging species which was later imported to its native country by nursery stock. It is so serious in some parts of Europe that the culture of the white pine has had to be abandoned. The same condition will doubtless be reached

[4] This is mentioned by Spaulding, Phytopath. 4: 4 (1914) in an abstract of a paper entitled "Notes on the white pine blister rust," and also by Stewart and Rankin, Phytopath. 4: 5. 1914.

in this country if every precaution is not taken to stamp out the disease. Recently the rust has been found fully established on large trees of native white pine in northern Vermont. Steps have been taken to extirpate it in this locality. The quarantine regulations of the various states and of the federal government are clearly efforts in the right direction. It may be found necessary eventually to prohibit importation of white pine stock.

Since 1909, and possibly earlier, the presence of a *Cronartium* on *Ribes longiflorum* has been known from Colorado through the collections of Mr. E. Bethel. The rust has been especially common in the parks of Denver and Boulder, and has appeared each year in the same spots since the first observation, but does not seem to have spread. Search at different times by Mr. Bethel has failed to reveal any aecial source of the infection. No white pines, or other species of pine which could be suspected of harboring the rust, grow in the immediate vicinity. A careful search was made at the Boulder station in August, 1911, by the writers aided by Mr. Bethel, and again in August, 1912, by the senior writer alone, but no additional evidence could be detected to explain the outbreak.

15. PERIDERMIUM COMPTONIAE (Arthur) Orton & Adams, Phytopath. 4: 24. 1914

Cronartium Comptoniae Arth. Bull. Torrey Club 33: 29. 1906.
Peridermium pyriforme [Peck, misapplied by] Arth. & Kern, Bull. Torrey Club 33: 419. 1906.

O. Pycnia unknown.

I. Aecia chiefly on small branches 0.5–2 cm. in diameter, or on the trunks of small trees 2.5–5 cm. in diameter, producing only slight fusiform enlargements, individual sori rounded or irregular, 1–1.5 by 1–2 mm. across, sometimes larger by becoming confluent, subhemispherical, 1–2 mm. high, rupturing irregularly along the sides; aeciospores ellipsoid or obovate, 16–24 x 24–33 μ; wall 2.5–4 μ thick, rather coarsely verrucose with irregular and somewhat deciduous tubercles, with a smooth area at base often extending up one side.

On *Pinus austriaca* Höss., Connecticut (*Clinton,* see Rep. Conn. Exp. Sta. for 1912, p. 354).

On *Pinus echinata* Mill., North Carolina (*Spaulding*, see Phytopath. 3: 309. 1913); Pennsylvania (Bear Meadows, Center County, May 26, 1913, communicated by *C. R. Orton*).

On *Pinus maritima* Poir, Connecticut (*Clinton*, see Rep. Conn. Exp. Sta. for 1912, p. 354).

On *Pinus montana* Mill., Connecticut (*Clinton*, see Rep. Conn. Exp. Sta. for 1912, p. 354).

On *Pinus ponderosa* Dougl. (cultivated), Massachusetts (Arnold Arboretum, May 28, 1884, specimen in Herb. Farlow); Wisconsin (Trout Lake, June 28, 1913, *Moody*, communicated by *A. G. Johnson*).

On *Pinus rigida* Mill., Connecticut (Storrs, June 4, July 5, 1907, *Thom*); New Jersey (Newfield, May, 1890, *Ellis*); New York (Albany, June 8, 1910, Hudson Falls, June 22, 1911, *Atwood*).

On *Pinus sylvestris* L., Connecticut (Rainbow, Experiment Station forest, June 15, 1907, *Clinton*, used for successful cultures on *Comptonia* by the collector); Missouri (fruticetum Missouri Botanical Garden, St. Louis, May 1887, *Pammel*); New York (Albany, May 19, 1911, in shipment of trees from Massachusetts, *Atwood*, in nursery at Bluff Point, near Plattsburgh, May, 1912, communicated by *Rankin*).

On *Pinus Taeda* L., New Jersey (*Spaulding*, see Phytopath. 3: 309. 1913).

On *Pinus virginiana* Mill (*P. inops* Ait.), New Jersey (*Ellis* in N. Am. Fungi *1021*).

DISTRIBUTION: Massachusetts to North Carolina westward to the Mississippi river from Wisconsin to Missouri, but chiefly eastward.

The species here represented is the one to which we misapplied the name *pyriforme* in our previous paper. In gross appearance it resembles somewhat the genuine *pyriforme* although it is usually on the smaller branches or stems while the latter is more often on larger limbs or trunks. In general appearance and in the habit of attacking the stems of seedlings and small trees this species is perhaps more closely allied to the white pine rust. It differs from that species very materially in microscopic spore characters, having larger, thicker-walled spores, which are verrucose with coarse, irregular, deciduous tubercles, rather than with uniform, permanent tubercles.

In several instances our attention has been called to the damage which this species is doing to seedlings of the Scotch pine in nurseries. The general similarity in appearance and habit has led some observers to suggest that perhaps the Scotch pine and white pine blister rusts might be the same species. In this connection the morphological differences above pointed out are of interest, but of still greater importance is the fact that Clinton has succeeded in culturing the Scotch pine rust on *Comptonia asplenifolia*. The relationship of the pitch pine specimens here listed to *Cronartium Comptoniae* is also unquestionable. With the data obtained from field observations, morphological characters, and infection experiments it seems that we are safe in concluding that the pitch and Scotch pine rusts are the same species and quite distinct from the white pine species.

More recently (June, 1913), specimens have come to hand showing that this species is also causing damage to *Pinus ponderosa* in a nursery in northern Wisconsin. Since the *Cronartium* on *Comptonia* has been collected in the same region the outbreak may be explained. With the exception of this locality and one in the fruticetum of the Missouri Botanical Garden, where an infected tree was doubtless planted, the species seems to be pretty well confined to the eastern United States.

Recently (Phytopath. **3**: 308. Dec. 1913) Spaulding has given an account of the injury which this species of rust has been observed to do among cultivated pines.

16. PERIDERMIUM CEREBRUM Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 68. 1873

Peridermium Harknessii Moore, Bull. Calif. Acad. Sci. **1**: 37. 1884.

Aecidium deformans Mayr, Waldungen Nordam. 119. 1890.

Aecidium giganteum Mayr, Waldungen Nordam. 120. 1890.—Bot. Centr. **58**: 149. 1894.

Peridermium deformans Tubeuf, Pflanzenkr. 429. 1895.

Peridermium giganteum Tubeuf, Pflanzenkr. 429. 1895.

Aecidium cerebrum Dietel, in Engler & Prantl, Pflanzenfam. **1**^{1**}: 79. 1897.

Aecidium Harknessii Dietel, in Engler & Prantl, Pflanzenfam. **1**^{1**}: 79. 1897.

Peridermium fusiforme Arth. & Kern, Bull. Torrey Club **33**: 421. 1906.

Peridermium mexicanum Arth. & Kern, Bull. Torrey Club **33**: 422. 1906.

Peridermium globosum Arth. & Kern, Bull. Torrey Club **33**: 424. 1906.

O. Pycnia indefinitely spread out over the surface of swellings similar to those on which the aecia appear, the overlying cortical tissues with a rather even surface, 40–50 μ high; pycniospores very numerous, globose, 1.5–2 μ.

I. Aecia appearing on globoid swellings 5–25 cm. across, or on fusiform swellings 2–6 cm. by 5–30 cm. long, usually encircling the comparatively small branches, often causing swollen areas only partially encircling the larger branches or main trunks, individual sori elongate or tortuous, sometimes distinct but often confluent so as to appear cerebroid; peridia circumscissile, soon falling away, sometimes in flakes or sheets; aeciospores obovate or ellipsoid, $15–24 \times 23–33\ \mu$; wall 2.5–4 μ thick, rather coarsely verrucose, with a smooth area at base often extending up one side.

On *Pinus contorta* Dougl., Alaska (*Trelease 667*).

On *Pinus Banksiana* Lamb. (*P. divaricata* Auct.), Connecticut (communicated by *Clinton*); Michigan (*Wheeler*); Wisconsin (Lone Rock, May 31, 1890, *Goff*, erroneously listed in former paper, Bull. Torrey Club **33**: 424, as on "*Pinus Strobus*," same locality, May 29, 1912, *Davis*).

On *Pinus echinata* Mill. (*P. mitis* Michx.), Arkansas (*Bethel, von Schrenk*).

On *Pinus radiata* Don. (*P. insignis* Dougl.), California (*Blasdale, Fawcett, Bethel*).

On *Pinus Murrayana* Oreg. Com., California (Yosemite Valley, May 29, 1895, *Blasdale*); Colorado (Bald Mt., Central City, July 4, 1908, Lake Eldora, July 21, 1910, Aug. 5, 1911, June 30, 1912, Silver Plume, Dec. 24, 1906, Tolland, July 30, 1906, Aug. 15, 1906 in Barth, Fungi Columb. *2243*, all by *Bethel;* Tolland, May 18, 1908, *Kern;* Long's Peak Inn, Estes Park, Aug. 7, 1908, *Clements*); Montana (Libbey, Oct. 15, 1911, *Wier 37*); the Colorado and Montana specimens are included here on morphological grounds although some doubt is thrown upon this disposition by the failure up to this time to find the alternate stage within this geographical range.

On *Pinus oöcarpa* Schiede, Jalisco (*Pringle*).

On *Pinus palustris* Mill., Florida (*Rolfs*), Texas (*Spaulding*).

On *Pinus patula* Schiede & Deppe, Hidalgo (*Pringle*).

On *Pinus ponderosa* Dougl.?, British Columbia (Communicated by *Fraser,* 1912), Washington (*von Schrenk*).

On *Pinus rigida* Mill., New Jersey (*Ellis,* in N. Am. Fungi *1022*, *Shear 1456*); New York (*Lintner*); Ohio (*Kellerman*).

On *Pinus sabiniana* Dougl., California (Colfax, *Harkness 28,* Newcastle, Feb., 1906, *Shear,* Placerville, *Fawcett,* Sept., 1913).

On *Pinus scopulorum* (Engelm.) Lemm., Nebraska (Chadron, Aug. 7, 1909, *Weaver;* Long Pine, May 13, 1896, *Bates 370,* as on "*Pinus ponderosa*").

On *Pinus Taeda* L., Alabama (Auburn, *Earle,* no date, April 1896, *Underwood,* type of *Per. fusiforme* Arth. & Kern, April 6, 1912, *Arthur* & *Kern,* April 7, *Arthur, Lloyd,* & *Kern,* March 22 and April, 1913, *Wolf,* the latter two used for successful cultures on *Quercus* by the writers); Florida (Gainesville, Feb. 2, 1906, *Rolfs,* same locality, March 7, 1910, *Burger,* Lake City, Feb. 26, 1909, *Rolfs*); Mississippi (*Tracy*).

On *Pinus virginiana* Mill., Delaware (Seaford, April 24, 1908, *Jackson*); District of Columbia (Washington, May 11, 1903, April 24, 1905, *Shear*); Maryland (Glen Sligo, May 5, 1905, *Ricker;* Takoma Park, May 10, 1906, *Shear,* used for successful cultures on *Quercus* by the senior writer; Takoma Park, April 14, 1907, *Shear;* College Park, Sept. 20, 1910, *Demaree*); North Carolina (Durham, May, 1911, *Wolfe*); Virginia (*Long, Shear*).

On *Pinus* sp., Georgia (*Ravenel, O'Gara*).

Type collected at Centre (now called Karner), New York, on trunks and branches of young pine trees, *Pinus rigida, J. A. Lintner* (the specimen in Herb. Peck bears in addition the date May, but no year is given).

DISTRIBUTION: Nearly throughout the United States, southward to central Mexico; and northward along the mountains to southern Alaska.

This species, as now represented, includes several of the forms which were previously regarded as distinct. The most notable advance in this connection has been the proof by our cultures this season (1913) that the *fusiform* specimens (*Per. fusiforme* A.

& K.), so common in the southern states, have their uredinia and telia on *Quercus*. Perhaps these specimens are sufficiently differentiated so that they might constitute a race but with only the present knowledge of their culture behavior we believe it best simply to include them in the *Cronartium Quercus* species. It is interesting to note that in doing this, after an attempted separation, the pendulum swings back to the original contention of Underwood and Earle (Bull. Torrey Club **23**: 405. 1896), in which they decided that these macroscopic characters should be disregarded, and not be allowed to "serve as specific characters of equal weight with those which require a microscope to detect." They included the fusiform specimens under *Per. cerebrum*. It seems possible that the form of the gall may be dependent to some extent upon the rate of growth taking place in the affected part at the time of infection and for a few months thereafter. The preponderance of the fusiform type of enlargement on *Pinus Taeda* in the south might be due to a more vigorous growth of the host following the infection period than is likely to take place in northern species and localities.

In separating the Wisconsin specimen under the name *Per. globosum* we were influenced to a large extent by supposed identity of the host and to a lesser extent by minor structural characters. The host was given as white pine by a well-known careful collector, but there were no leaves with which to verify the determination. Dr. J. J. Davis has since visited the original locality and finding there only the ordinary *Per. cerebrum* on *Pinus Banksiana* suggested an error with regard to our statement. A portion of the twig was then submitted to Mr. C. T. Humphrey, of the Forest Products Laboratory, University of Wisconsin, who gives it as his opinion that the host cannot be *Pinus Strobus* and that it has all the chief characters of *Pinus Banksiana*. Further microscopic study has also shown us that we laid too much emphasis on the variations noted in the peridial cells. We are, therefore, convinced that the founding of the species was unwarranted. Essentially the same condition holds for *Per. mexicanum* which is also now included under *Per. cerebrum*. With regard to this form we were influenced by slight structural variations and also by the geographical location. The subsequent

knowledge that the *Cronartium* on *Quercus* occurs also in southern Mexico has greatly assisted us in coming to the present conclusion.

Considerable advance has been made also in the knowledge of the development of the aecial stage. With the aid of Dr. C. L. Shear the existence of the pycnial stage has been demonstrated, and a brief technical description has been included in the above diagnosis. Dr. Shear also points out that the fungus seems to have a biennial development, at least he is sure in some cases that only pycnia develop the first season following infection. Two years would thus be required for the development of the aecia.

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THE DEVELOPMENT OF STROPHARIA AMBIGUA

Sanford M. Zeller

(With Plates 124 and 125, Containing 12 Figures)

In the fall of 1911, the writer's attention was called to an agaric which is very conspicuous in fir woods in the vicinity of Seattle, Washington, during the fall and winter months. Specimens have been collected as late as January 17. For this work the very young stages were collected in the fall of 1912. As far as the writer is aware, no study of the development of the genus *Stropharia* has been published and there appears to be doubt about the taxonomy of this particular species.

The earlier literature on the development of the fruiting bodies of the Agaricaceae has been thoroughly reviewed by Atkinson (2), Allen (1), and Beer (3). In 1906, Atkinson found that in the early stages in the development of *Agaricus campestris* there was no differentiation, but a universal veil surrounded the homogeneous mass of hyphae. The first differentiation was the primordium of the hymenium in the form of a deeply stained ring a little above the center of the carpophore and lying some depth under the surface. The gill cavity forms below this hymenium, and the primordium of the pileus is distinguished from that of the stem and marginal veil. Next in the order of development the pileus becomes definitely outlined quite deeply under the surface by taking a deep stain.

In the same year, Allen (1) found the development of *Hypholoma* to be different from that of *Agaricus*. In *Hypholoma* the universal veil is present from the beginning, and the first differentiation is a small central area which stains deeply. This differentiates successively into the primordium of the pileus, hymenium, and upper portion of the stem. The gill cavity is formed internally after the formation of the primordium of the hymenium, and the lamellae are formed by the differential growth of the hyphae of the hymenial primordium.

Three years later, Fischer (4) published his work on the development of *Armillaria mucida*, in which he observes that the hymenial primordium has an endogenous origin, but that the primordium of the pileus precedes the appearance of that of the hymenium.

In 1911, Beer (3) followed with his notes on some species of Agaricaceae. In his work upon *Hypholoma fasciculare*, he practically confirmed what Allen (1) had already reported for *Hypholoma*, while in *Armillaria mellea* he found the sequence of the differentiation of parts and their development to correspond very closely with Atkinson's observations upon *Agaricus campestris*.

During November, 1912, specimens were collected on the campus of the University of Washington. No trouble was experienced in finding all stages from the youngest to the fully developed carpophores. The mycelium in the form of white, silky rhizomorphs was found just under the surface of the decayed organic matter on a moss-covered log of *Alnus oregana*. The rhizomorphs measure about 0.5–1 cm. in diameter. The pure white buttons were easily obtained from the surface of this substratum. Several mature carpophores aided much in locating the tiny button forms, which were readily identified by their viscid upper surfaces. Buttons 1–5 mm. in diameter, and portions of more mature carpophores were fixed in chromo-acetic acid and were carried through alcohol and xylol into paraffin. The sections were generally cut 6 μ thick. In staining, the best results were obtained with acid fuchsin and picric acid, to bring out the early differentiations. The safranin, gentian-violet, and orange combination was used to advantage in older stages. A large number of slides were made and the accompanying plates were photographed from slides chosen from these.

The early stage of the carpophore is an undifferentiated mass of interwoven hyphae which reaches a height of about 1.5 mm. At this time it is about 1 mm. in transverse diameter. Figure 1 shows the earliest stage. Over the surface of this primordial carpophore there is a layer of coarser, more loosely arranged hyphae. This is the universal veil. For the most part, the hyphae of the interior extend vertically from the base where the carpophore is connected with the rhizomorph. Sections of the latter

show it to be made up of a pseudo-parenchymous tissue. In the upper part of the carpophore the hyphae seem to spread and their course is generally parallel with the surface.

The first sign of internal differentiation of the previously homogenous tissue appears in a plane a little above the center of the primordium of the carpophore. Here in medial vertical section two darkly stained patches of descending hyphae appear (Fig. 2). These seem to be the regions of most active growth and are rich in protoplasm. In the remaining sections of the same carpophore these deeply stained areas can be traced as an annular area in the whole carpophore. This is the hymenial primordium. The hyphae of this region are very slender and pointed at first, but eventually they enlarge and become crowded, their lower ends forming an even surface. After this differentiation to form the primordium of the hymenium, an inverted cup-shaped layer of hyphae, rich in protoplasm appears. This extends upward from the outer edge of the hymenial primordium and over the top of the carpophore, remaining the same distance from the surface over the whole area. This forms the primordium of the pileus (Fig. 3). Simultaneously with the differentiation of the pileus the gill cavity is formed by the sagging of the neutral tissue below the hymenial primordium, due to the cessation of growth in that region. Figure 4 shows the primordium of the hymenium enlarged. The primordium of the hymenium increases in width at the outer edge, where the hyphae begin to grow downward and inward as if to form the incurved margin of the pileus. At this stage the partial veil can be distinguished as tissue of lighter stain, extending from the universal veil and the pileus margin to the outer surface of the upper portion of the stem, which is now clearly differentiated (Fig. 5).

Next, a differential growth takes place in the hymenial hyphae. Radial plates of these hyphae grow downward rapidly and form ridges, which are the first signs of the lamellae. As soon as these appear, the hyphae of the gills spread laterally, leaving a groove along the edge of the lamella. In the very earliest stages of the development of the lamellae they are differentiated into a lightly staining central region, and the heavily staining lateral regions made up of the tips of the hyphae. The vertical tangential sec-

tions (Figs. 6 and 7) show this feature. The central light region is the primordium of the trama of the lamella, while the heavily staining lateral regions are sections of the hymenium of the lamella. The broadening of the lamellae is brought about by the downward intercalary growth of fine, sharp-pointed hyphae in the trama. When their tips reach the groove at the edge of the lamella, they turn horizontally to form the hymenium. The hyphae of the hymenium are not large enough at this stage to stand out distinctly, but soon distinct, scattered, swollen hyphae stand out above the hymenium surface. These are cystidia. They are clavate, measure 20–22 μ long and 8–10 μ broad, and have large, deeply staining nuclei 4–6 μ in diameter.

As the lamellae grow in width, the trama becomes thicker because of the intercalary growth of new hyphae. But in a later stage, as shown by the sections of older lamellae (Fig. 8), the hyphae of the trama have increased in diameter causing the thickening of the trama in the upper part of the lamellae. At this stage, as Allen (1) also observed in *Hypholoma*, the cystidia appear greatly separated, indicating that some intercalary growth has taken place in the hymenium. A few observations have led to the belief that this hymenial growth is due to the branching of hyphae at the clamp connections in the subhymenium. The basidia are of the typical form and have four spores.

At an early stage, when the carpophores are about 4 mm. in diameter, the portion of the universal veil directly above the pileus dissolves into a viscid layer, and the cortical layer of the pileus secretes enough viscid substances to keep it coated through the rest of its development. In older specimens this viscid layer is about 0.1 mm. thick (Fig. 8). However, very small, pure-white patches of the universal veil may persist along the outer margin of the pileus until late stages. Figures 9 and 10 show this character and also the thick partial veil completely concealing the lamellae. In a still later stage this partial veil ruptures about midway between the stem and the margin of the pileus. It is thus left partially appendiculate to the margin of the pileus and partially as a distinct, white annulus which is striately lamellate on its upper surface (Figs. 10–12). In some specimens the

annulus is early evanescent, but in most it persists to old age. It is difficult to keep dried specimens with the annulus intact.

This species was reported as new by Peck (6) in 1898. The specimens from which the determination was made were sent by Dr. Lane from Portland, Oregon. Peck says, "The dried specimens have the general appearance of some species of *Stropharia,* but the appendiculate character of the veil and the *entire absence* of an annulus indicate that the species is a *Hypholoma*." Then, in 1912, Murrill (5), in summing up the species of *Hypholoma* of the Pacific Coast, says of this one: "The species belongs naturally in *Stropharia,* but the large veil is *entirely* appendiculate and leaves *no* annulus." Figure 12 is a photograph of a specimen of my collection, No. 91, referred to by Murrill (5). The dried specimens of this collection which were sent to him for determination probably have no annulus intact.

In the light of the present investigation there are two lines of differentiation between this species and *Hypholoma.*

First, in the early states of *Hypholoma,* as worked out morphologically by Allen (1) and later verified by Beer (3), the differentiation of the parts does not correspond to that of this species. In *Hypholoma* the differentiation of the pileus preceded the other parts. Beer (3) also says that in *Clitocybe laccata* "the first differentiation of the carpophore primordium consists in the demarcation of the pileus." In *Stropharia ambigua* the first differentiation is the appearance of the primordium of the hymenium. Atkinson (2) found this true in *Agaricus campestris,* and Beer (3) observed the same order of development in *Armillaria mellea.* Thus, according to our present knowledge of the development of the carpophores of the Agaricaceae, with one exception the annulate forms develop the hymenial primordium first, while other forms develop the primordium of the pileus first. Fischer's work (4) on an annulate form may show an exception; but it seems to the writer that according to Fischer's findings the differentiation of the hymenium brings about the differentiation of the pileus, and Beer (3) suggests that the differentiation of the pileus and hymenium in this case is possibly simultaneous. Further investigation on these two types has been started by the writer.

Second, there is an annulus present in this species. This feature has been noticed with interest since specimen No. 91 was determined (5). Students in a course in Fungi at the University of Washington have invariably traced it to the genus *Stropharia*. It is true that a part of the veil is characteristically appendiculate but the greater part forms a pendulous annulus, which is thick, membranaceous, and pure-white, but for the purplish-brown edges of the striate lamellae on the upper surface. The annulus is cone-shaped, has a fimbriate margin, and is fixed.

Since it is evident from these two standpoints that this plant has been taxonomically misplaced, the new combination **Stropharia ambigua** (*Peck*) is proposed.

The lamellated upper surface of the annulus brings *S. ambigua* into close relationship with the little *S. bilamellata* Peck (7). However, *S. ambigua* is much larger and leaves a portion of the veil appendiculate.

The writer is under obligations to Dr. J. W. Hotson for helpful suggestions in this work.

SUMMARY

1. The species in question does not develop like *Hypholoma,* but like the annulate forms.

2. In its young stages it has an annulus which is sometimes evanescent.

3. Therefore the new combination, **Stropharia ambigua** (Peck), is proposed.

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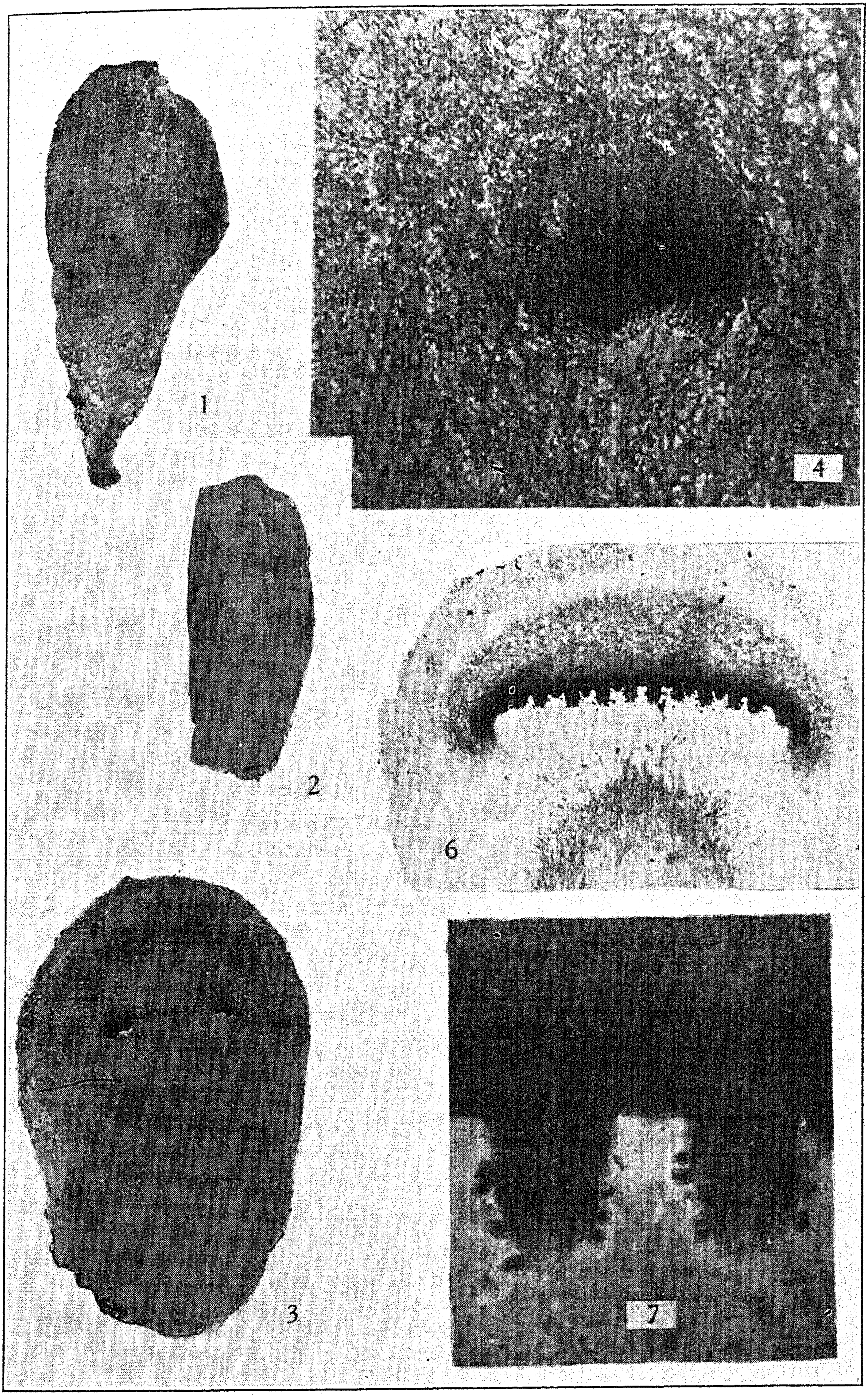
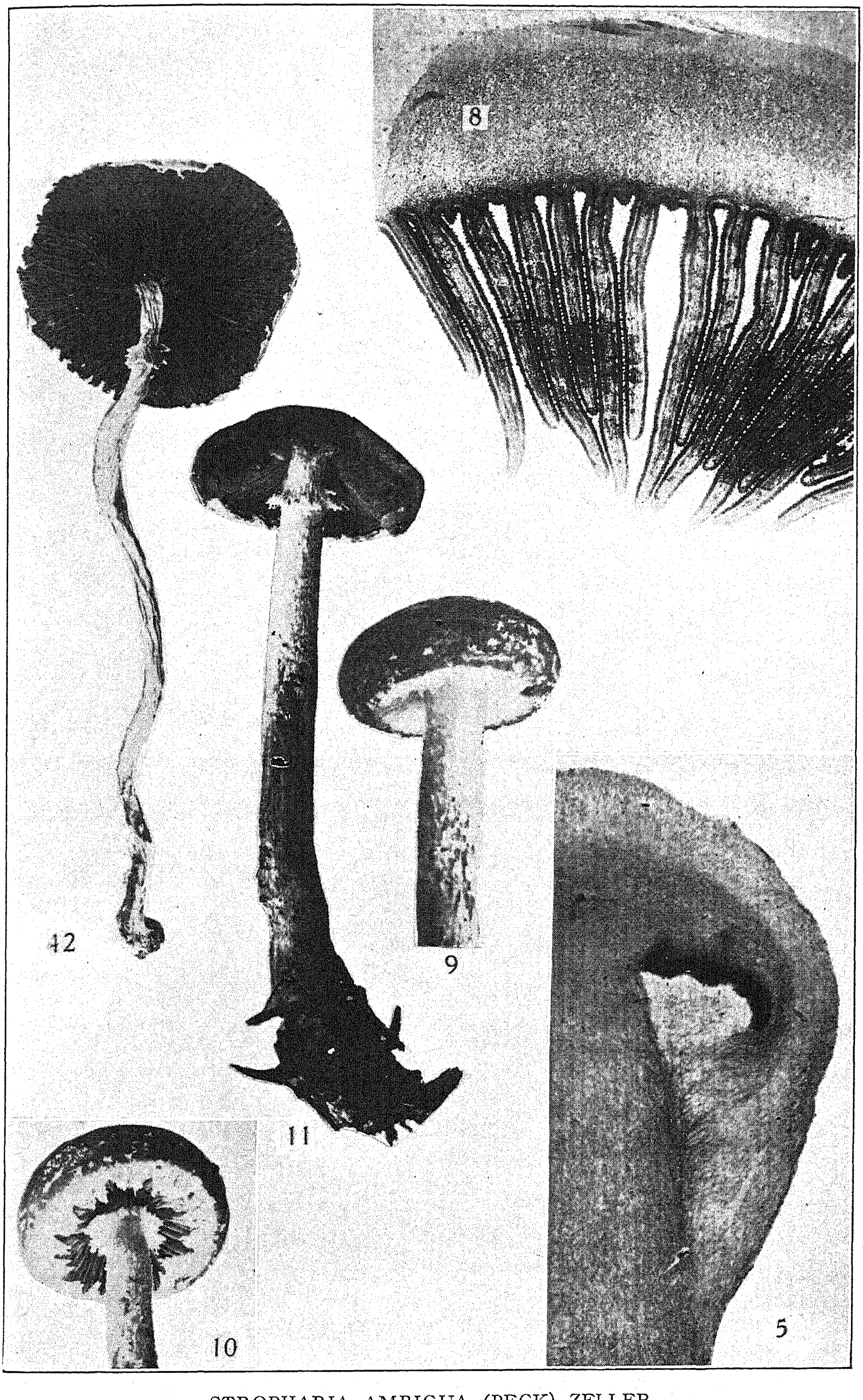


STROPHARIA AMBIGUA (PECK) ZELLER



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DESCRIPTION OF PLATES CXXIV AND CXXV

Photomicrographs by Homer O. Blair and photographs by the author.

Fig. 1. Young carpophore undifferentiated; × 30.

Fig. 2. Young carpophore with hymenial primordium developed, but no evidence of the primordium of the pileus; × 30.

Fig. 3. Young carpophore showing the hymenial primordium farther developed than in Fig. 2 and the appearance of the primordium of the pileus; × 30.

Fig. 4. From same young carpophore as Fig. 3; the primordium of the hymenium showing the beginning of the gill cavity; × 300.

Fig. 5. Part of young carpophore showing the gill cavity; the primordium of the hymenium continues to develop as the margin of the pileus continues to grow; young lamellae in longitudinal section; partial veil of loose filaments; and cortex of the stem; × 30.

Fig. 6. Tangential section of young carpophore showing young lamellae in cross section; the lightly staining central portion is the trama; cystidia; × 30.

Fig. 7. Greater magnification of the same lamellae as shown in Fig. 6, showing the trama, hymenium and cystidia with large spherical nuclei; × 300.

Fig. 8. Tangential section of more mature pileus and lamellae; the trama of the pileus; superficial viscid layer; trama, subhymenium and hymenium of the lamellae; × 60.

Fig. 9. Pileus of carpophore showing small flocculent patches of the universal veil and the partial veil completely covering the lamellae. Nat. size.

Fig. 10. Carpophore showing partial veil ruptured leaving annulus and partly appendiculate. Nat. size.

Fig. 11. Same object as Fig. 10 with part of pileus cut away to show annulus. Nat. size.

Fig. 12. Dried specimen (Zeller, No. 91) showing annulus. Nat. size.

MOUNTAIN MYXOMYCETES

T. H. Macbride

Slime moulds are such ubiquitous things that we might imagine all species universally distributed and the forms of one locality precisely those of every other, once the lists are with accuracy compared. This might well be the case indeed since these forms are manifestly sown by wind currents, their spores swept by every aerial movement, probably round and round the world.

Furthermore, slime moulds, in the nature of the case, are essentially woodland things; they affect the shade, love rotting logs and piles of fallen leaves, and one might expect to find them alike in all the forests of the continent. But such is by no means the situation. These curious heirs of primitive life differ in different forests, and vary from mountain range to mountain range, and up and down the meridians of the world, quite as do the higher plants. They respond readily to environmental change and become fixed at length in haunt and habitat.

The variation is accordingly more marked where isolation and climatic differentiation are more complete. Thus there is more concord if we compare the forests of Maine and Washington than when we attempt to study together the Rocky Mountains and the Cascades. Maine and Washington are near the ocean; the Rocky Mountains are far interior; the mountains about Puget Sound are visited by abundant rains, the Rocky Mountains are semi-arid; stretch across the "great American desert."

This opens a wide subject. It is not expected here to do more than call attention to the problem. This we may effect by presenting briefly the slime-mould species of the two regions latest named, comparing particularly Colorado and the shores of Puget Sound. Most of the work in Colorado has been done by Professor E. Bethel and Professor W. C. Sturgis; I myself have been busy on the Pacific coast. For some reason, not clear to me at present, the Colorado field is remarkable for its wealth of calcareous types: at least in the light of present knowledge, the

physarums and their kin abound in the Rocky Mountains about Denver and are scarce in the far West. Conversely about Puget Sound the trichia and lamproderma types are practically universal and dominant.

A few notes of species, cited in detail, may make this situation clear.

The one calcareous slime-mould everywhere in the west from the islands of San Juan to the glaciers of Mt. Rainier is the familiar *Fuligo, F. septica* L., we must finally say. So far as my observation goes, in the Washington forest every day from July to January, but one phase of the species is to be found, viz.: *F. ovata* Schaeffer. Generally specimens are rather small, but on the foot hills of the great mountain they are not only abundant but extremely large. On decaying stumps in a hemlock forest the yellow plasmodia seemed to affect the landscape, so many of them all around, so large, that the foamy plasma might have been dipped up with a cup!

In contrast with this we have in Colorado three described species, and no knowing how many phases of these species, in the protean genus. The species are distinguished chiefly by spore-characters. Thus, *F. septica* L. has spores almost smooth, pale violaceous 6–7 μ; *F. ellipsospora* R. has spores ellipsoidal, dark-colored, rough, 10–12 μ; *F. megaspora* Sturg., spores globose, very dark and rough, 18–20 μ. There is still another form repeatedly taken in Colorado with globose spores dark-colored and rough, about 10–12 μ in size. This is dull gray and fits in between the first and third named, and might be called *F. media*.

We have in the west beautiful colonies of *Lepidoderma*, probably *L. tigrinum* (Schrad.) R.; in the Rocky Mountain district this is reported "found but once in Colorado." This is a calcareous type, it is true, but looks rather in the direction of *Stemonitis*.

But it is in the great genus *Physarum* itself that the contrast becomes more apparent. Here the Colorado lists include some twenty-two species to which the Iowa herbarium may add one or two. Here is one that we may call *Physarum elegans*, very much like *P. pusillum* (Berk.) Lister, but with larger, orange or brown, short-stalked, sporangia. Here is another that has porcelain-like

walls, uniform capillitum with the usual violaceous rough spores, but unlike anything in the *P. nephroideum* group. Other calcareous genera are equally represented: there are about eight didymiums, four or five didermas, etc.

Mucilago spongiosa (Leys) Morg. in the forests about Mt. Rainier is not at all uncommon. Its flecks of spume sometimes deck the stems and twigs of living plants all along a water-course. The light calcareous foam blows away as soon as dry, and leaves a curious dendritic, strangely intricate, grayish fructification quite confirming Rostafinski's figure 175. In Colorado, on the other hand, the same species retains its limey covering, shows almost no internal structure, and is almost as firm as the substratum, justifying Professor Sturgis when he writes var. *solida*.

To nearly all the Colorado forms so far discussed, one remark applies: they are peculiar. Even where representing species widely known and studied, the Rocky Mountain gatherings would nearly all be subject of remark no sooner seen. Furthermore the peculiarity is, I believe, in many cases referable to the abrupt alternation in Colorado climate. Plasmodia called into being by the melting snows of early summer are often checked in complete development by the dry atmosphere suddenly encountered as they rise to fruit, and abnormality is the result. The most normal presentations I have from Colorado are of those species which habitually fruit in less exposed positions, as on the lower side of stems, logs or heaps of mouldering vegetation. Such species are *Badhamia utricularis* (Bull.) R.; *Comatricha nigra* (Pers.) Schr.

The *Fuligo* species cited are worthy of further notice. It is of course observed that the spores in the three more closely related forms are singularly graded in size; thus—*F. septica*, 6–7 μ; *F. media*, 10–12 μ; and *F. megaspora*, 18–20 μ.

Knowing what we do, by the researches of Harper, concerning the cytology of *Fuligo*, this correlation in size is very suggestive. Professor Harper has shown that the uninuclear spore is the issue of a peculiar plasmodical cleavage, whose progress in a given case may be arrested almost anywhere; so that we might have reproductive bodies by this process ranging from large sclerotia to the smallest spores.

Turning now to the Puget Sound collections, it is to be noted that we have from both Oregon and Washington less than a dozen physarums, three didymiums so far and only three or four didermas, and these not abundant. On the other hand cribrarias are on every log, and although the number of species of *Trichia* or *Hemitrichia* is not large, the number and extent of their colonies is surprising. *T. decipiens* and *T. botrytis* are the common types, but neither is like forms of the same species as presented in the central parts of the continent. They are in every case larger; they open in sharply circumscissile fashion, standing in colonies often several feet in extent. *T. botrytis,* if such it be, is not quite Persoon's species, it is not botryoid at all. I have never seen so many as two sporangia adhering. Later on, the large empty vases of both species stand long, quite like those of *Hemitrichia clavata.*

But robust comatrichas and lamprodermas are the striking features of the myxo flora about Puget Sound. These are everywhere; lamprodermas at sea-level and comatrichas on the mountains; on Mt. Rainier up at the last limit of the firs, 8–9,000 ft., I found *C. nigra* (Pers) Schr. and especially *C. suksdorfii* Ell., beautiful and abundant sepcimens. Stemonitis species are few and rare; the colonies feeble when found, except at low levels where at least two species occur, but not *S. splendens* R.

At 7,000 ft. *Arcyria vitellina* Phill. particularly the form *A. versicolor* occurs in wide colonies of large sporangia, twice the size of those seen in Colorado. *A. versicolor,* is olivaceous yellow with touches of dull red. *A. vitellina,* pure yellow, is in Colorado and Southern California.

But the lamprodermas of the Mt. Rainier neighborhood are, as just stated, all a surprise. They all merit Ellis's name *robusta,* and their far stretching colonies all gleaming in marshalled and metallic splendor are beautiful to behold.

In fine, not to prolong this argument, so far as present knowledge goes, the slime-mould floras of the two mountain regions named are distinct as the mountains themselves. Dominants and recessives no doubt play their respective parts, but meteoric environment ultimately casts the die.

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NEWS, NOTES AND REVIEWS

The *Journal of Agricultural Research* for January contains an account by Della E. Ingram of a disease caused by a fungus which is referred to *Diplodia longispora* Cooke & Ellis. While the disease usually attacks the chestnut oak, it may also attack the chestnut and other species of oaks. The trees are not killed outright but may die as a result of weakening from the attacks of the disease. The disease gains access to the plant through wounds in the bark.

Contribution No. 144 from the Botanical Department of the University of Michigan is a record of researches on the mycorrhizas of forest trees by W. B. McDougal. As a result of this work, four species of fungi are added to the known list of ectotropic mycorrhiza-forming fungi, as follows: *Russula* sp. on *Tilia americana*, *Boletus scaber fuscus* on *Betula alba papyrifera*, *Cortinarius* sp. on *Betula alba papyrifera*, and *Scleroderma vulgare* on *Quercus alba*. It is stated that at least four different species of mushrooms may form mycorrhizas on the same tree.

It has recently been shown by F. C. Stewart and W. H. Rankin, of Geneva, New York, that it is probable that *Cronartium ribicola* rarely, if ever, winters over on the currant as it has been suspected of doing from the severe outbreak of the currant rust in that vicinity. This rust in its aecial stage is known as *Peridermium Strobi* and affects those species of *Pinus* which have their leaves borne in clusters of five. The rust is perennial on the pine but cannot spread directly from one pine to another. The recent outbreak of currant rust was found to be due to two pine trees infected with the blister-rust.

The New York Botanical Garden recently acquired the Mycological herbarium of William R. Gerard, who died suddenly in New York City, February 26, 1914. He was born in Newburgh, N. Y., March 26, 1841, and in boyhood entered the employment of a druggist in Poughkeepsie; remaining in the same business until finally he became proprietor of a drug store in that city.

He began the study of fungi at a time when few American botanists had devoted attention to this group of plants, his first descriptions of new species appearing in the *Bulletin of the Torrey Botanical Club* for October, 1873, before the publication of the earliest mycological papers of Burrill, Ellis, Farlow, or Morgan. In the following year, he was one of the founders of the Poughkeepsie Society of Natural Science, in whose *Proceedings* a number of his botanical papers were published. In 1877, he removed to New York City, where he was an active member of the Torrey Botanical Club for some years. Before the death of William H. Leggett, the founder and editor of the *Bulletin,* Mr. Gerard was made assistant editor, and he followed him as editor, filling that office from April, 1882, to December, 1885. In later years he was interested in the derivation of plant names, especially those of American Indian origin, and contributed papers on this subject to *Garden and Forest* in 1895 and 1896. Otherwise, his botanical studies seem to have ended with the year 1885.

AGARICUS XYLOGENUS Mont.

Agaricus (*Psalliota*) *xylogenus* Mont. Syll. Crypt. 122. 1856 was described as follows from plants said to have been collected by Sullivant on dead wood near Columbus, Ohio, in August: "Pileus conic to campanulate, umbonate, 3–6 cm. broad; surface smooth, luteous, fuscous at length on the umbo, margin striate when dry; stipe white, 7 cm. long, 5 mm. thick, slightly larger at the base, hollow, with a persistent annulus below the middle; lamellae free, remote, rose-colored as in *A. campestris;* spores globose, 5–7.5 μ, discolored-hyaline; related to *Agaricus cepaestipes.*"

Sullivant had two collections numbered 140. The plants described, which do not grow on wood, resemble a *Lepiota,* with long, slender stipe, brown umbo, and a good superior annulus, but no scales such as occur in *L. procera.* They are neither *L. cepaestipes* nor *L. Morgani.* The other No. 140, called 140^2 by Montagne, is totally different from the one described and is attached to dead wood, thereby deserving the specific name. The pileus is white, glabrous, apparently viscid, distinctly umbonate,

3 cm. broad in the dried state; lamellae white, crowded; stipe slender, glabrous, slightly enlarged below; annulus inferior.

W. A. MURRILL.

A NEW BOOK ON THE BRITISH RUST FUNGI*

In 1889, Plowright brought out the first monographic account of the rusts of England. In the twenty-four years which intervened before the next comprehensive treatment of the group by Grove, in 1913, it is not surprising to find that sufficient information has accumulated to make the latter presentation much more bulky than the former. Plowright treated both the rusts and smuts in a single volume of 347 pages, while Grove requires in the present volume 412 pages for the rusts alone. The two authors have treated their subject in a very similar manner, giving first the biology, or natural history, of the group and following it with a systematic part which includes descriptions, hosts, and distributions. Plowright devotes 57 pages to the natural history of the rusts and 135 to their classification, whereas the later author uses 84 and 300 pages, respectively, for the two parts.

The expansion of the biological part by Grove is due partly to the fact that some entirely new topics, notably sexuality and separation of species into races, have been developed in the interim and partly to the fact that he treats at greater length the life histories of certain typical forms. It is interesting to note that *Puccinia Caricis* instead of *P. graminis* has been selected for extended consideration as "the typical Uredine." The author explains that he has done this because the aecia of *P. graminis* are rare and difficult to obtain for demonstration, while that of *P. Caricis* is common. In the second, or systematic portion, the increase in the recent book is due chiefly to the larger number of species included, although the more complete descriptions with somewhat fuller notes would call for more space. A comparison of the two main genera, *Puccinia* and *Uromyces*, will throw some light on the taxonomic situation from the standpoint of the species. Plowright included 100 species of *Puccinia* and 38 of *Uromyces*, while Grove has added 37 species of *Puccinia* and 10

* The British Rust Fungi. By W. B. Grove, M.A., Pp. xii, 412. 290 text figs. Cambridge: at the University Press. 1913.

of *Uromyces*. As to genera, the situation is perhaps still more striking, Plowright having included all species under 11 genera as compared with a list of 24 by Grove. It must be noted, however, that some genera have been discussed which have not yet been collected in England, but which the author apparently believes may be found there at any time on account of their prevalence in Europe.

The book is well printed, profusely illustrated, and makes a neat appearance. The illustrations are original and highly satisfactory. They are very similar to those in Fischer's Uredineen der Schweiz, from which work the general form of the drawings seems to have been adapted.

The author very generously acknowledges that the descriptions of species are based upon Sydow's Monographia Uredinearum. In some instances it is regrettable that this work has been followed so closely as to include some of its errors. The descriptions are said to be revised and amended but evidence of culture work or first hand investigations of many of the special problems is usually lacking. Other writers' opinions are rather freely cited, but there is frequently considerable hesitation about the adoption of results if they differ from the usual disposition. In the citation of names, the dates have been intentionally omitted. As they are frequently important and would have required no additional space and little extra time in preparation, there seems to be no sufficient reason for such a procedure.

Sometimes statements in the biological discussions are of such a nature, either because of incompleteness or dogmatic form, as to attract attention. On p. 33, in a discussion of germ-pores in urediniospores, the statement is made that only one species of *Puccinia, P. monopora,* is known with the urediniospore possessing a single pore, although *P. uniporula* was published in 1912 (Orton in MYCOLOGIA 4: 201). Since that time the reviewer has found *Puccinia Veratri* and an undescribed *Uredo* on *Geranium mexicanum* to have 1-pored urediniospores, which suggests that the character is probably not so rare as was believed formerly. The conception of amphispores as given on p. 34 is not very clear, as is evidenced by the fact that Fig. 22 is given as an amphispore of *Puccinia Pruni-spinosae,* and that in the technical de-

scription on p. 208 amphispores are not mentioned in this species, while Fig. 156*b* is an exact duplication of Fig. 22, and is labeled "uredospore." Those who are interested in the evolution of the group will note that the author has very decided opinions in the matter when he states without qualifications that *Endophyllum*, whose aeciospores germinate as soon as mature with a basidium, represents "the primitive state of things from which the present wide division of labor into rejuvenating (aecidio-), multiplying (uredo-), and resting (teleuto-) spores has been evolved." Of wide interest also is the observation that "immunity depends chiefly (perhaps entirely) upon the ability of the cytoplasm to resist infections by secreting antitoxins which will kill the mycelium of the fungus."

FRANK D. KERN.

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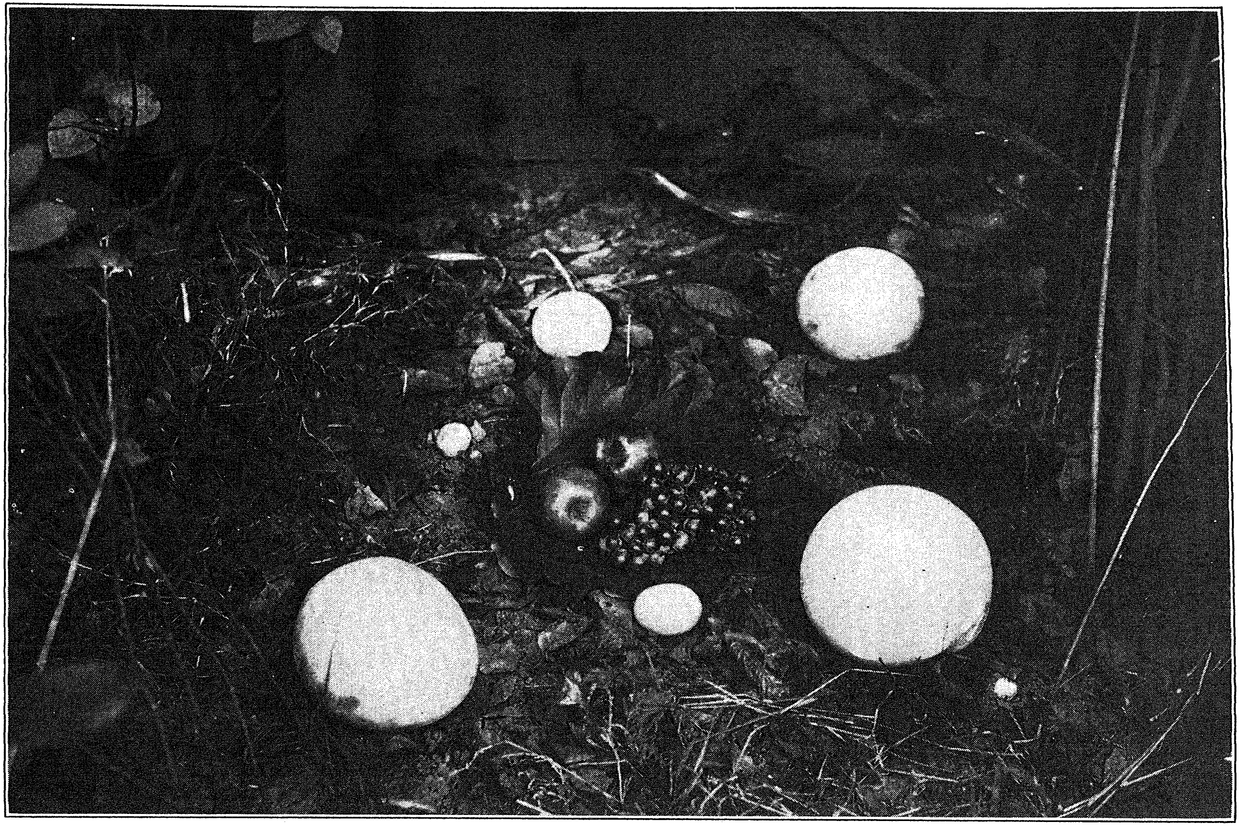


LYCOPERDON BOVISTA L.

MYCOLOGIA

VOL. VI JULY, 1914 No. 4

ILLUSTRATIONS OF FUNGI—XVIII

WILLIAM A. MURRILL

The accompanying plates were made from specimens collected in the vicinity of New York City or in adjoining states within easy reach. The species selected are of such a character as to be well represented without the use of color. Several of them are of importance to the mycophagist.

Lycoperdon Bovista L.

Lycoperdon giganteum Batsch

GIANT PUFFBALL

Plate 126. × ⅛

Peridium very large, globose or depressed-globose, sessile or nearly so, 20–35 cm. or more in diameter; surface glabrous or slightly flocculose, white, whitish, or slightly yellowish, becoming dingy with age; spores globose, greenish-yellow becoming dingy-olivaceous, 4 μ; capillitium greenish-yellow becoming dingy-olivaceous.

The giant puffball, easily recognized by its large size and smooth white appearance, occurs infrequently in fields, pastures, or woods throughout most of the United States, as well as in parts of Europe and Asia. The specimens here figured grew in Mrs. Boeder's yard in Williamsbridge, New York City, and were photographed by her. The species has also been collected at least twice in the hemlock grove in the New York Botanical Garden. Authentic records have been made of specimens three feet in diameter, but they rarely become much larger than a man's head. The flavor of

[MYCOLOGIA for May, 1914 (6: 103–159), was issued May 30, 1914]

this species is particularly good, and little cooking is required. The writer remembers coming suddenly some years ago upon four large giant puffballs grouped picturesquely about an old stump in a beech grove near Ithaca, New York, and the pleasure he had, not only in gazing at them, but in getting them home and distributing them in quarter sections to a number of his friends.

Lycoperdon pyriforme Schaeff.

PEAR-SHAPED PUFFBALL

Plate 127. × 1

Peridium pear-shaped, 2.5–5 × 2–3 cm., dingy-white or brownish, with white, branching mycelium; cortex of thin, minute, often persistent scales or granules, or of short, stout spinules; inner peridium smooth, very thin, concolorous, opening apically; subgleba small, white, rather compact, of minute cells; spores globose, smooth, greenish-yellow to brownish-olive, 3.5–4 μ; capillitium of long, branched threads, which form a dense tuft in the center, columella present.

This species occurs very commonly in dense clusters on decayed wood or humus throughout most of the United States and Canada, as well as in Europe and Asia. As a rule, the smaller puffballs are poorly flavored and this one is particularly so; but it may be used when everything else is scarce. I have often eaten quite young specimens of this species late in the fall, flavoring them with bacon, parsley, onion, butter, salt, and pepper, and adding, if convenient, a few sporophores of the common mushroom.

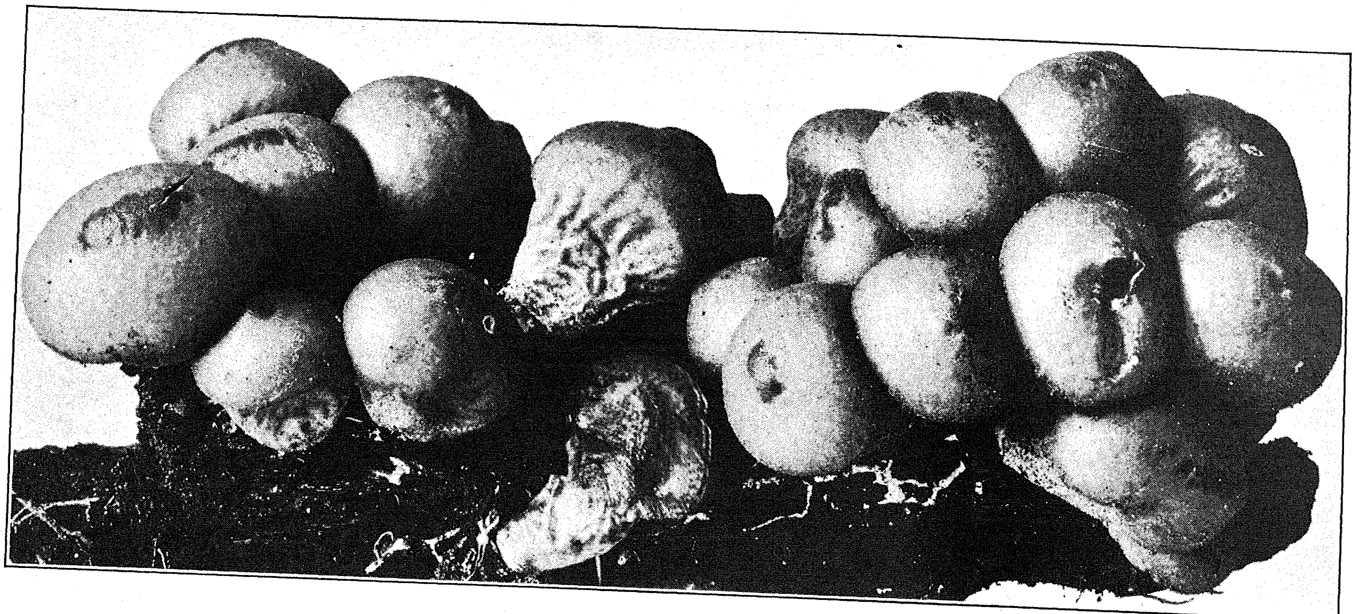
Sparassis Herbstii Peck

HERBST'S SPARASSIS

Plate 128. × 1

Sporophore much branched, whitish inclining to creamy-yellow, 10–12.5 cm. high and 12.5–15 cm. broad; branches numerous, thin, tough, moist, flattened, concrescent, dilated above and spatulate or fan-shaped, often somewhat longitudinally curved or wavy, mostly uniformly colored, rarely with a few indistinct, nearly concolorous, transverse zones near the broad entire apices; spores subglobose or broadly ellipsoid, 5–6.2 × 4–5 μ.

This species was originally described from specimens collected by Herbst at Trexlertown, Pa. The accompanying photograph is



LYCOPERDON PYRIFORME SCHÆFF.

from plants collected in wood's near New Rochelle, New York, by Miss Daisy Levy. This species is closely related to *Sparassis crispa,* which is often seen in European markets. It is edible, but unfortunately too rare to be of economic importance.

Asterophora Clavus (Schaeff.) Murrill

Nyctalis asterophora Fries

CLUB-SHAPED ASTEROPHORA

Plate 129. × 1

Pileus hemispheric to depressed, usually distorted, gregarious, 1–2.5 cm. broad; surface white to fawn-colored or brownish, floccose, spongy, usually powdered with the brownish chlamydospores; margin involute, thick; context thick, fleshy, grayish-white, of farinaceous taste and odor; lamellae thick, dull-grayish, distant, adnate, usually undeveloped; spores not seen; chlamydospores large, stellate, brownish, 15–20 μ; stipe pruinose, white to brownish, stuffed or hollow, brown within, 1.5–2.5 cm. long, 3–8 mm. thick.

This tiny and peculiar parasitic agaric occurs on decaying sporophores of *Russula, Lactaria, Chanterel, Clitocybe,* and other large species of gill-fungi throughout Europe and the eastern United States. The sporophores are usually partly decayed and blackened before the parasite comes to maturity. The gills are fold-like as in *Chanterel,* and the surface of the pileus often bears large star-shaped conidia, which give it a powdery appearance.

Collybia maculata (Alb. & Schw.) Quél.

SPOTTED COLLYBIA

Plate 130. × 1

Pileus fleshy, firm, convex or nearly plane, 5–10 cm. broad; surface even, glabrous, white or whitish, often variegated with reddish spots or stains; context white; lamellae narrow, crowded, adnexed, sometimes nearly or quite free, white or whitish; spores subglobose, at times slightly apiculate at one end, 4–6 μ; stipe firm, striate, white, usually stout, equal or subequal, often curved below, commonly attenuate and radicate at the base, 5–10 cm. long, 6–12 mm. thick.

This species is one of the largest of the genus and occurs in humus or on much decayed wood in woods throughout the greater

part of the eastern United States, as well as in Europe. The surface is usually decorated with reddish spots or stains, but varieties occur in which these spots are entirely absent.

Hygrophorus eburneus (Bull.) Fries

IVORY HYGROPHORUS

Plate 131. × ⅔

Pileus fleshy, moderately thick, sometimes thin, convex to expanded, 3–8 cm. broad; surface very viscid or glutinous, completely covered with a coating of gluten, entirely white; context having a mild and not unpleasant odor; lamellae strongly decurrent, distant, with vein-like elevations near the stipe; spores ovoid, granular $6–10 \times 5–6\,\mu$; stipe spongy to stuffed within, sometimes hollow and tapering below, 6–15 cm. long, 3–8 mm. thick.

This attractive edible species is widely distributed throughout the cooler regions of Europe and America, occurring on the ground in woods or in partially shaded places. The writer found it to be one of the most common and abundant species on the Pacific coast. In many localities, a basketful could have been gathered in a very small area. Its white color, slimy covering, mild odor, and decurrent, distant gills will serve to distinguish it from closely related species.

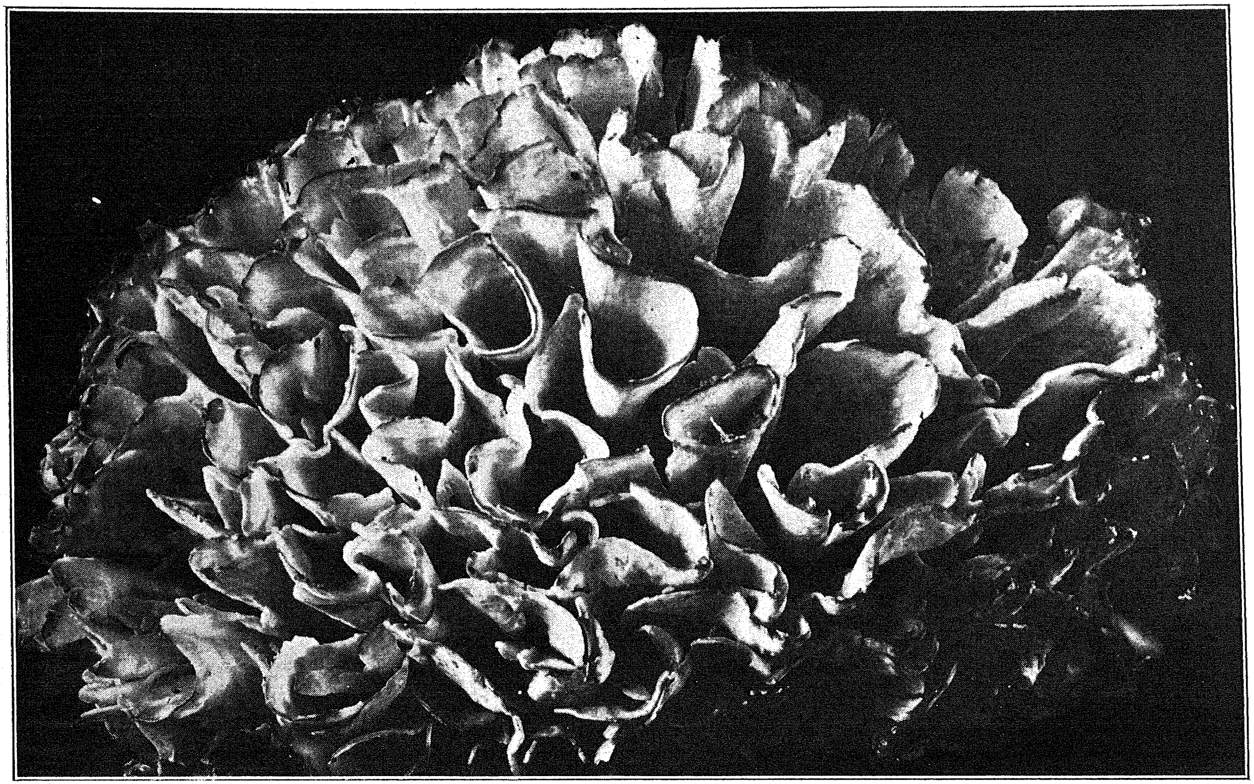
Lactaria piperata (L.) Pers.

PEPPERY LACTARIA

Plate 132. Lower Figure. × ½

Pileus fleshy, convex-umbilicate, at length infundibuliform, 4–12 cm. or more in diameter; surface white, azonate, dry, glabrous; margin involute at first and naked, at length uplifted; context compact, white, unchanging or becoming sordid, edible; latex white, unchanging, very acrid, abundant; lamellae white or creamy-white, forking dichotomously, close, more or less decurrent, arcuate at first, then extending upwards, only about 2 mm. broad; spores white, subglobose, nearly smooth, $8–9\,\mu$ in diameter; stipe white, equal, dry, often pruinose, solid and firm, 2–8 cm. long, up to 2 cm. thick.

Found in great abundance in oak woods throughout temperate North America, as well as in Europe. It contains an acid and a resin, "piperon," which is extremely acrid in the fresh state, but



SPARASSIS HERBSTII PECK

is disorganized by heat. This species is therefore harmless when cooked, but is coarse and poorly flavored. If eaten, it must be carefully distinguished from poisonous species that are acrid in the fresh state.

Lepiota naucina (Fries) Quél.

SMOOTH LEPIOTA

Plate 133. × 1

Pileus thick, globose to convex, 5–8 cm. broad; surface dry, usually white and smooth, at times slightly yellowish or granular on the disk; context firm, fleshy, white, mild; lamellae free, white, dull-pinkish with age; spores usually white in mass, rarely tinged with pink; stipe white, smooth, enlarged below, bearing a white annulus above, 6–10 cm. long, 8–16 mm. thick.

This excellent and widely distributed temperate species occurs in the autumn in lawns and pastures where the common mushroom grows and is often picked and thrown away because the lamellae are white. There is no harm in using it for food if the collector and those who may imitate him distinguish it carefully from the white variety of *Venenarius phalloides,* which is so common in this region and has been the cause of most of the deaths among mushroom eaters in the vicinity of New York City. It must be remembered that this deadly species is picked by some persons for the common mushroom, in spite of its white lamellae and bulbous stipe. How much more easily might *Lepiota naucina,* which has both characters, be confused with it! The deadly *Amanita phalloides* may be distinguished from *Lepiota naucina* by the "death-cup" at the base of the stipe, by the longer and usually more bulbous stipe, and by the gills remaining white instead of becoming slightly dull-pinkish with age.

Agaricus campester hortensis Cooke

GARDEN MUSHROOM

Plate 134. × ⅔

This variety of the common mushroom has been found in great abundance in an old pile of cow manure east of Bronx Park, partly shaded by weeds. It differs from the form usually found in pastures which was described and figured in MYCOLOGIA for March, 1909, chiefly in its slightly larger size, darker color, and more con-

spicuous scaly covering. This variety is often cultivated but is rarely found wild.

Psathyrella disseminata (Pers.) Quél.

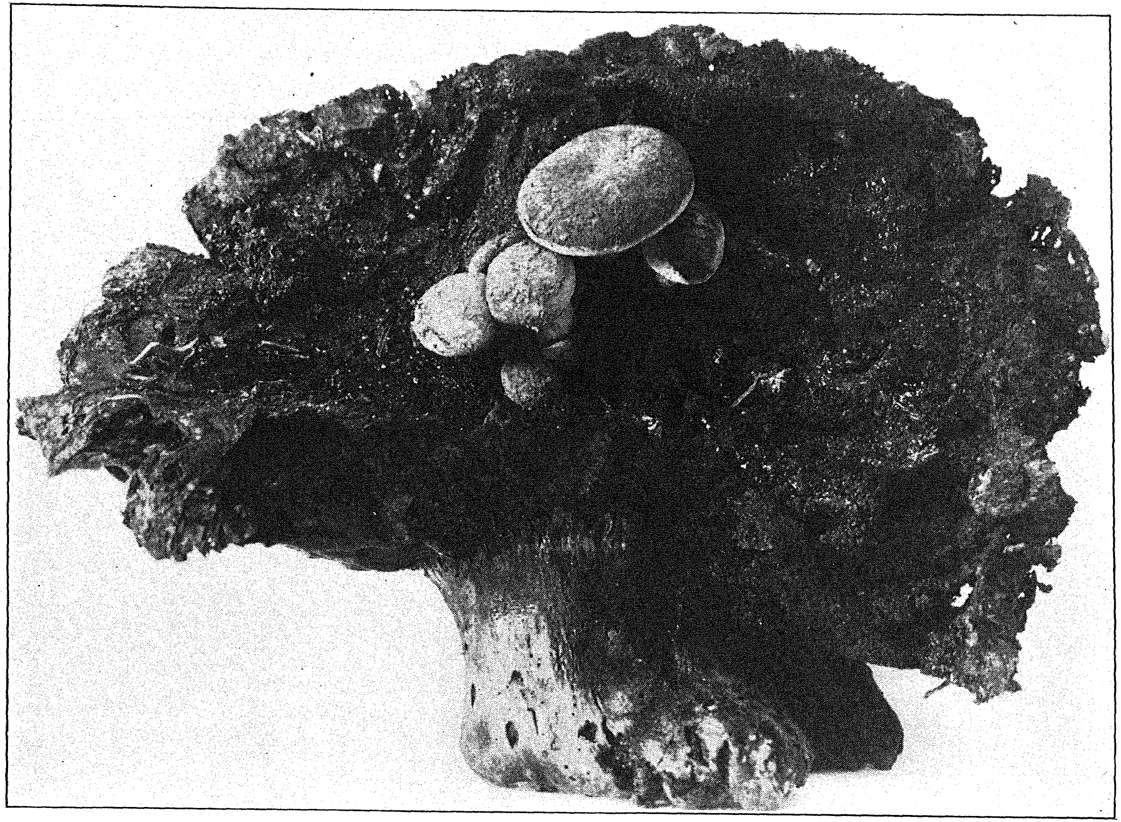
SCATTERED PSATHYRELLA

Plate 132. Upper Figure. × 1

Pileus membranaceous, ovoid-campanulate, densely gregarious or cespitose, 6–10 mm. broad; surface minutely scaly becoming smooth, whitish, gray, or grayish-brown; margin sulcate-plicate, entire; lamellae adnate, broad, white to gray, then black; spores ellipsoid, $8 \times 6 \mu$; stipe furfuraceous to glabrous, yellowish to cinereous, very slender becoming hollow, often curved, about 2.5 cm. long and 1 mm. thick.

This small and very beautiful species is widely distributed in Europe and America on decayed wood and moist earth containing organic matter, the caps occuring in such large numbers in one spot that it is entirely impossible to count them. It may be looked for throughout the season from early summer until late autumn and it often appears on the soil in greenhouses during the winter. The species strongly suggests *Coprinus,* both in its mode of expanding and in blackening with age, when the black spores are mature.

NEW YORK BOTANICAL GARDEN.



ASTEROPHORA CLAVUS (SCHÆFF.) MURRILL

A CONSIDERATION OF THE PROPERTIES OF POISONOUS FUNGI

William W. Ford and Ernest D. Clark

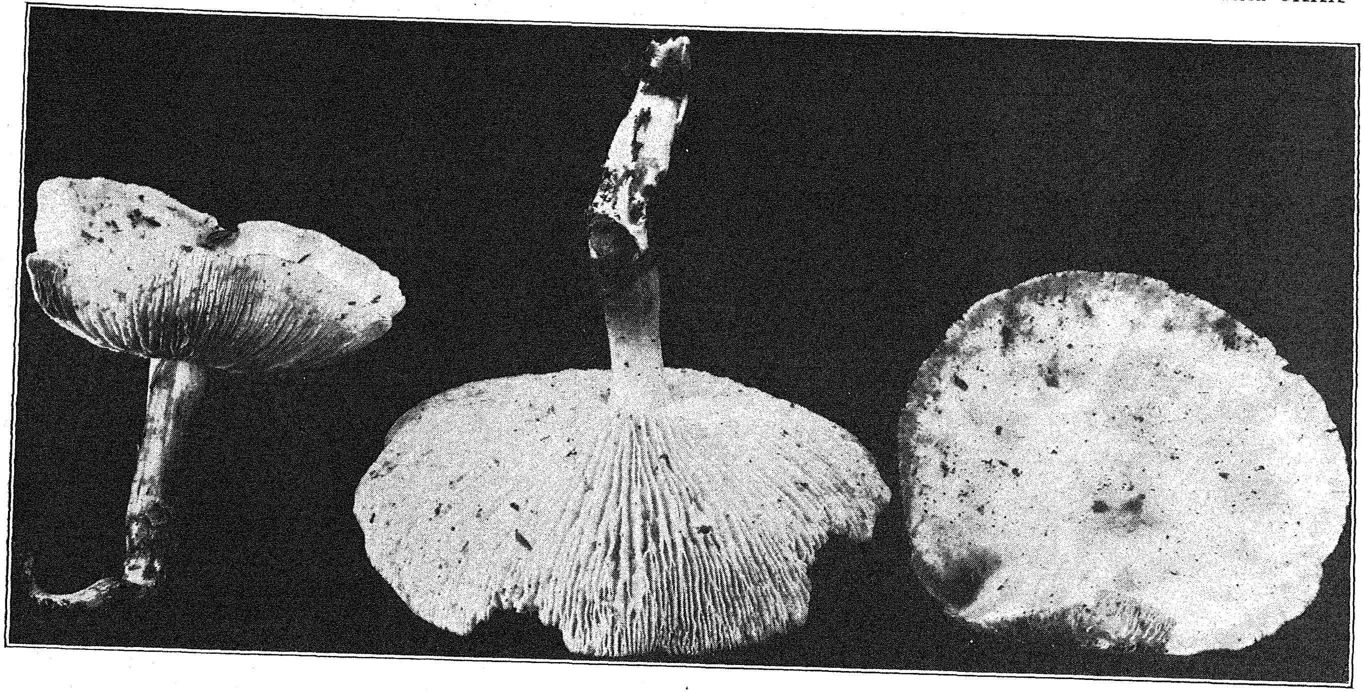
Introduction

The collection of edible fungi, commonly spoken of as mushrooms in contradistinction to the poisonous varieties known as toadstools, has become more and more popular during the past few years in America. On the one hand, the number of well-trained mycologists who undertake the study of fungi during the summer months as a scientific pastime, regardless of the dietetic value of the material they obtain, has been greatly augmented by those individuals who look everywhere for the edible species which they have learned to identify with great accuracy. In consequence, mushroom collecting has become something of a fad in many of our summer resorts and during September and October the fields and pastures are pretty thoroughly searched for such species as the meadow mushroom, *Agaricus campestris.* On the other hand, this country has seen, during the past decade, a great influx of peasants from Italy, Hungary and Bohemia where even the children know the difference between poisonous and harmless mushrooms. As a result, many of the edible species of fungi which grow in the woods are gathered by this foreign-born population either for themselves or for sale in the local markets. In consequence of this greater interest in the subject, mushroom poisoning has become somewhat more common in America despite the warnings issued from time to time, both to native Americans who are ignorant of the first principles of mycology, and to our foreign-born citizens who are misled by the variations in color and other properties which fungi exhibit in different countries. Poisoning by fungi, however, is by no means a modern occurrence. Indeed, mushrooms have been collected from time immemorial, according to Paulet,[1] in such countries as Russia, China, Hungary, Italy, and especially in Tuscany; being exhibited for sale in the public markets in cities like Pekin, St. Petersburg, and Florence.

It is also well known that the ancient Babylonians and the early Romans employed mushrooms in great quantity both as delicacies for the rich and as daily food for the poorer classes.

In early times, knowledge of the properties of fungi must have been gained entirely from experience and the accurate training of the peoples of the old world in the distinctions between the poisonous and harmless varieties could only have been obtained from many accidents. How common mushroom poisoning actually was, however, is not known to us. It must have been fairly frequent since the deaths of several notables from this cause have been recorded in history, not as occurring from some unexplained phenomenon but from accidents of a nature well-recognized by their contemporaries. Of such victims may be mentioned the family of the Greek poet Euripides, including his wife, two sons, and a daughter; Pope Clement VII; Emperor Jovian; Emperor Charles VI; Emperor Claudius; and a number of others.[2] Coming down to more modern times our first definite knowledge of the number of fatalities from mushrooms came from Paulet[1] who states that from the year 1749 to 1788 there were a hundred deaths in the environs of Paris alone. About the time of Paulet, Bulliard,[3] the celebrated French mycologist, began to systematize the knowledge of fungi possessed by men of his generation, established the various species upon firm ground, gave accurate descriptions of their botanical characters, and pointed out their physiological properties. Indeed, many of the species of the present day were established by this tireless French mycologist.

More recently, our knowledge of the extent to which mushroom fatalities may occur in France has been augmented by the publications of Bardy[4] who reported 60 cases in that district known as Les Vosges, and of Guillaud[5] who estimated the number of deaths in the southwest of France at about 100 annually. Falck[6] has also reported 53 cases in Germany with 40 deaths, and at the same time Inoko[7] in Japan has reported over 480 cases of mushroom intoxication in eight years. In this country Palmer,[8] of Boston, collected 33 cases with 21 deaths and Forster,[9] of Charlestown, 44 cases with 14 fatalities. Finally, in 1900 Gillot[10] found over 200 authentic cases of mushroom poisoning mostly in France and Ford,[2] a few years later, added nearly as many more found in the German,



COLLYBIA MACULATA (ÁLB. & SCHW.) QUÉL.

English and French literature since 1900. More recently Clark and Smith[11] have called attention to the great increase of mushroom poisoning in this country and have indicated that many of these cases take place within a few days' time. Thus, in September 1911, 22 deaths occurred in the vicinity of New York City in one period of ten days. The same point is also clear in the recent statistics given for France by Sartory[12] who records 249 cases of fungous poisoning with 153 deaths due chiefly to *Amanita phalloides* and a few *Entoloma lividum.* Of these, 90 per cent. occurred in the short time between August 26th and September 10th, 1912. Finally, one of the best of the modern French publications on poisonous fungi is that of Ferry[13] former editor of the Revue Mycologique who has given an excellent account of the most recent work in this field. A number of different species of mushrooms are poisonous, the symptoms which occur depending upon the presence of definite chemical substances in the plants. This can best be illustrated by a consideration of each species independently.

POISONING BY AMANITA PHALLOIDES BULLIARD

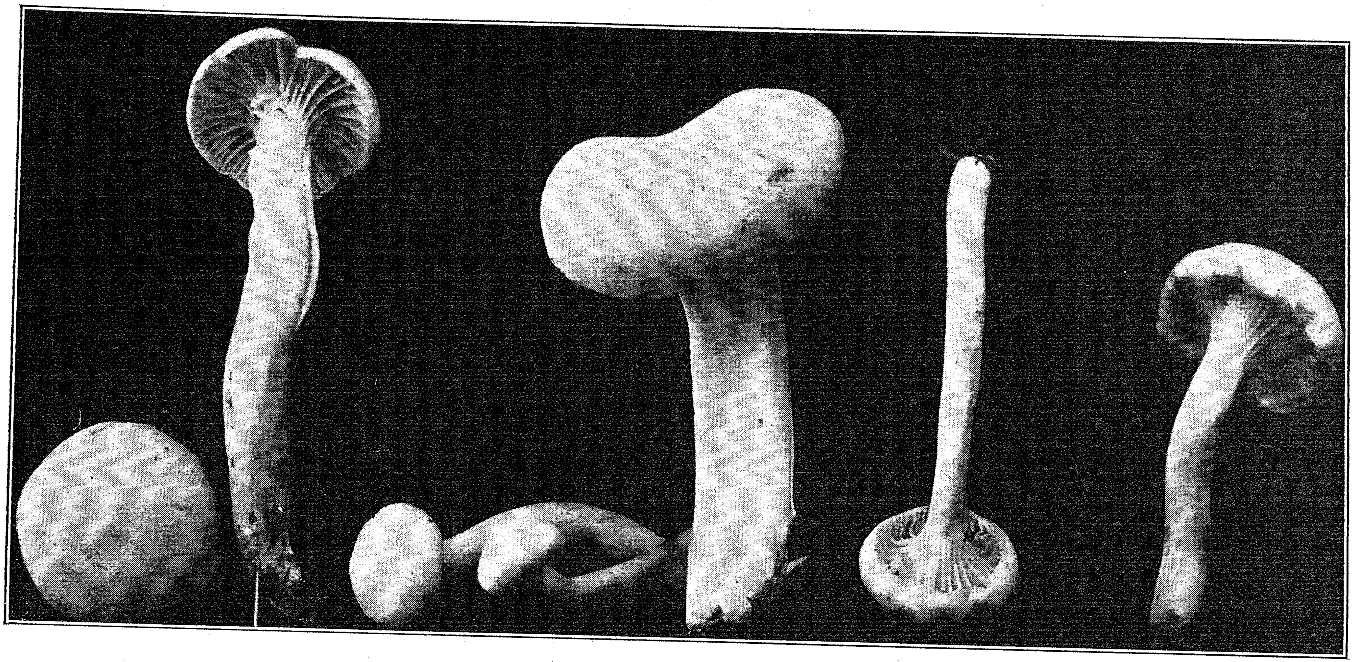
Botanical features

The vast majority of cases of mushroom intoxication are caused by *Amanita phalloides,* the white or deadly Amanita. The earlier species such as *Amanita bulbosa* Persoon and its varieties, *alba, citrina, virescens* and *olivacea, Agaricus bulbosus* Bulliard, *Amanita viridis* Persoon, *Amanita venenosa* Persoon and a number of others are without doubt identical with *Amanita phalloides.* In older French literature it is known as "l'orange ciguë," "l'orange blanche ou citronée," "l'orange ciguë jaunâtre" and "l'orange souris" and in the German as "Knollblätterschwamm." This species has a characteristic appearance and should be readily recognized by collectors of even limited experience. It usually grows to a height of 5–7 inches and its white spores, its ring or annulus and its base or cup (frequently called the poison cup) render its identification comparatively simple. The colors of the pileus, varying from brownish amber to yellow, are important, but are not as a rule regarded as of specific value. In Europe the pileus is usually greenish in color, but in America the green-

ish color is rarely seen. *Amanita phalloides* usually grows in the woods but this rule is by no means univeral. Occasionally, plants are to be found out in the open pastures near the margin of dense forests or in the grassy spots in the roads leading to and from them.

Clinical aspects

In poisoning by *Amanita phalloides* the clinical symptoms are practically always the same. After a prodromal stage of six to fifteen hours in which no discomfort is felt, the victims are suddenly seized by severe abdominal pain, cramp-like in character, and accompanied by vomiting and diarrhoea. Vomitus and stools consist of undigested food with much blood and mucus. Anuria is usually present and rarely constipation develops. Hemoglobinuria does not occur. Paroxysms of pain and vomiting alternate with periods of remission, the extreme suffering producing the Hippocratic facies described by the French as "la face vulteuse." The loss of strength is rapid and excessive. Jaundice, cyanosis, and coldness of the skin develop within a few days, followed by profound coma from which the patient does not rally. There is no fever. Convulsions are absent in the early stages and when present in the late stages are usually a terminal event. Ocular symptoms also do not usually occur. The course of the disease lasts four to six days in children and eight to ten in adults but if large quantities of the fungus are eaten a very profound intoxication develops and death may occur within 48 hours. The mortality in "phalloides" intoxication is extremely high, varying from 60 to 100 per cent., and is dependent somewhat upon the amount of the poisonous material ingested and probably somewhat upon the treatment. It requires surprisingly small quantities, however, to bring on fatal consequences and there are numerous deaths on record from eating one or two good-sized specimens. Plowright[14] has reported the death of a child of ten years from the consumption of about a third of the top of a small plant eaten raw. Recovery after ingestion of any quantity of *Amanita phalloides* may be regarded as extremely rare but not impossible. There is no difficulty in distinguishing between a poisoning due to this fungus from one due to other species such as *Amanita muscaria* since the entire clinical course of the disease is different.



HYGROPHORUS EBURNEUS (BULL.) FRIES

Autopsies upon individuals killed by *Amanita phalloides* have been carried out by a number of observers but our knowledge of the lesions is by no means satisfactory. There is little to be found to account for the violent paroxysms of pain, vomiting, and diarrhoea. Death seems to be due to the extreme fatty degeneration of the liver. The poisoning resembles most closely phosphorus poisoning (Ford[15]).

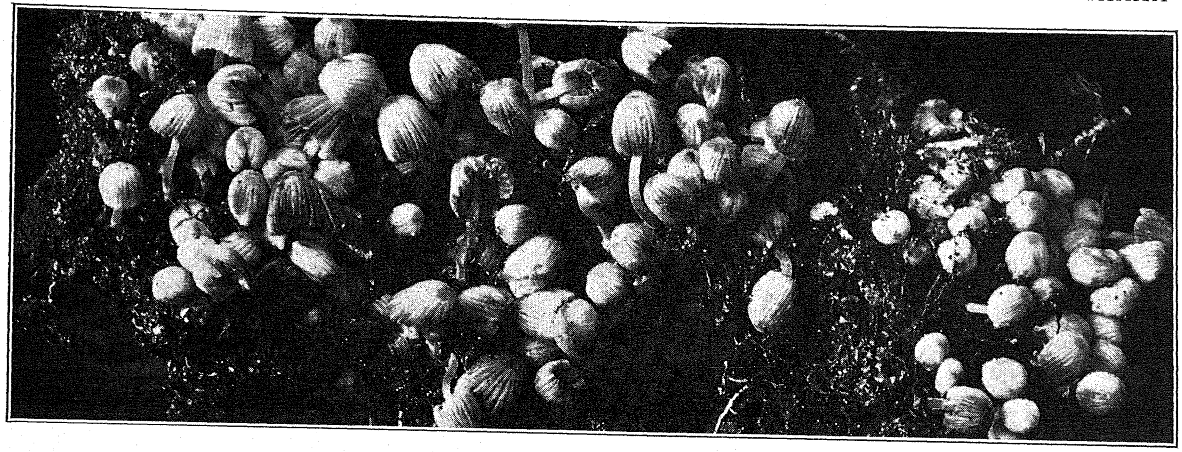
Poisonous constituents

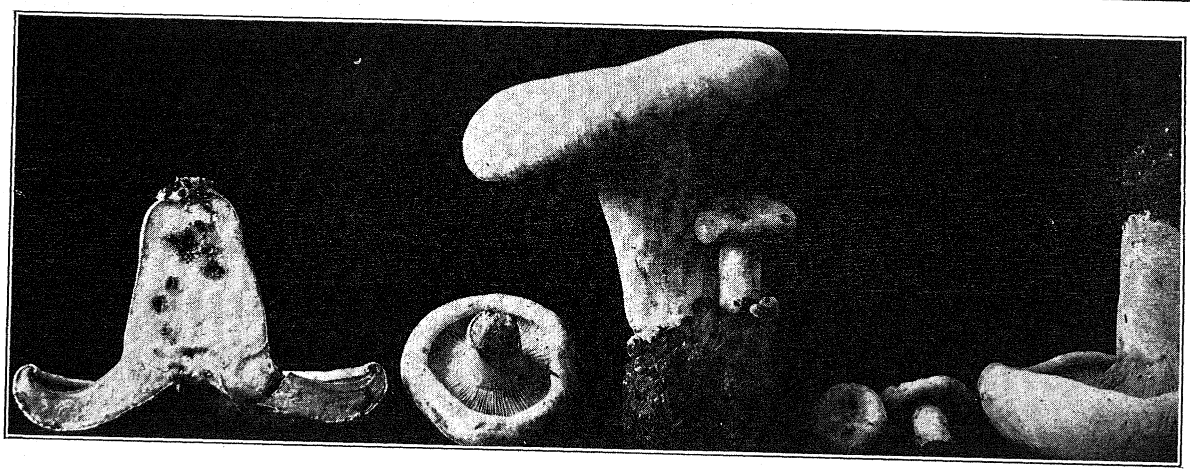
The first attempt to obtain the active principle or poison of *Amanita phalloides* is probably that of Letellier,[16] who in 1826 obtained a heat-resistant substance from a number of fungi and to his investigations we owe the term amanitin. Many years subsequently he took up the work again in association with Speneux[17] examining this time a fungus known as *Hypophyllum crux melitense* (Paulet) and probably a variety of *Amanita phalloides*. In this investigation two substances were found, one of an irritating nature, acting upon the mucous membranes of the alimentary canal, and the other heat-resistant substance characterized as a glucosidal alkaloid and identical with the amanitin of Letellier. In 1866 Boudier[18] made an elaborate chemical analysis of *Amanita phalloides* obtaining about a dozen different substances. He ascribed the poisonous action of the plant to an alkaloid but was never able to isolate such a substance although he gave it the name bulbosine. Later, in 1877, Oré[19] also concluded, on biological grounds alone, that *Amanita phalloides* must contain an alkaloid and he gave this hypothetical poison the name phalloidin.

The observations of all these men are interesting now only historically as the names ascribed by these various investigators to the active principle of *Amanita phalloides* are no longer employed except occasionally in French literature. Modern knowledge of the properties of this plant dates from the work of Kobert[20] who established the important fact that extracts of *Amanita phalloides* contain a substance which lakes or dissolves the blood corpuscles of many animals and of man. There were certain serious objections to regarding this substance as the active principle, especially the fact that this blood-laking or hemolytic material is very easily destroyed by moderate heat, much less than is usually em-

ployed in cooking, and that individuals dying of *Amanita phalloides* intoxication do not show symptoms which are to be ascribed to this kind of a poison. Nevertheless, Kobert at once jumped to the conclusion that this blood-laking substance which he named phallin was the essential poison of the plant and his discovery was hailed everywhere as one throwing brilliant light upon this most obscure poisoning. The term phallin has gotten into mycological literature all over the world and the idea that *Amanita phalloides* intoxication is due to this remarkable substance which dissolves or eats up the blood corpuscles has something so romantic about it that few have cared to question the correctness of Kobert's conclusions. Kobert himself, however, discovered that blood-laking materials were lacking from many specimens which he afterwards collected and identified as *Amanita phalloides* but that the plants did contain an alcohol-soluble substance which was extremely poisonous to animals. This latter substance he regarded as an alkaloid while phallin he placed in the group of protein-like poisons known as toxalbumins.

Subsequent work upon *Amanita phalloides* has been conducted chiefly by American investigators. It was first shown by Ford[21] that extracts of *Amanita phalloides* contain the hemolytic material described by Kobert and in addition a heat resistant body which will reproduce in animals the majority of the lesions described in fatal cases of *Amanita phalloides* intoxication in man. These two substances were named by him the amanita-hemolysin and the amanita-toxin. The further chemical study upon the plant was carried out by Abel and Ford,[22] by Schlesinger and Ford[23] and Ford and Prouty.[24] According to their investigations *Amanita phalloides* always contains two poisons, the hemolysin and the toxin. The hemolysin is a highly complex glucoside, insoluble in alcohol, easily destroyed by heat and by the action of the digestive juices. While this substance may play a rôle in cases of phalloides intoxication in man there is little or no evidence that it does so under ordinary circumstances. It is present in such a great amount in the plant, however, that the possibility of its having a poisonous action when the fungus is eaten raw or when the digestive secretions are altered in character can not be entirely eliminated. The active principle of the plant is the





UPPER FIGURE. PSATHYRELLA DISSEMINATA (FERS.) QUÉL.
LOWER FIGURE. LACTARIA PIPERATA (L.) FERS.

alcohol-soluble toxin. This resists the action of heat, of drying, and of the digestive juices and reproduces in animals the lesions of phalloides intoxication in man. Chemically, the toxin cannot be characterized definitely but the purest preparations do not give the reactions of either proteins, glucosides, or alkaloids. Fungi cooked by the same methods which are employed in the kitchen are entirely free from hemolysin but have a poisonous action upon animals which is identical with that seen with the amanita-toxin. With our present knowledge the amanita-toxin may be regarded as the active principle or essential poison of *Amanita phalloides.*

Treatment

There is no satisfactory method of treating individuals poisoned by the deadly amanita. It is essential that competent medical advice be obtained as soon as possible and every effort made to rid the alimentary canal of the noxious material in the hope of doing so before enough poison is absorbed to bring on fatal results. Active emetics and purgatives should be administered at once and in case these are not effective the stomach should be washed out and the lower bowel irrigated. Even then, it is frequently impossible to prevent the absorption of the poison which takes place with great rapidity. In the later stages stimulants should be employed with great freedom in the hope of tiding the patient over the periods of weakness. Narcotics should be employed to relieve the intense pain and whenever convulsive movements are seen. *Atropin has no effect in Amanita phalloides intoxication* and no reliance should be placed upon the drug in poisoning by the deadly amanita. Efforts to manufacture a curative serum by the immunization of animals with the poisons in this fungus have thus far been unsuccessful.

POISONING BY OTHER WHITE AMANITAS

A number of other amanitas have poisonous properties identical in all respects with *Amanita phalloides.* The most important of these are *Amanita verna,* the "destroying angel" of Bulliard, which is far more common in America than the true *Amanita phalloides, Amanita virosa* Fries, *Amanita spreta* Peck and *Amanita phalloides* variety *citrina.* All these species are recognized to be deadly

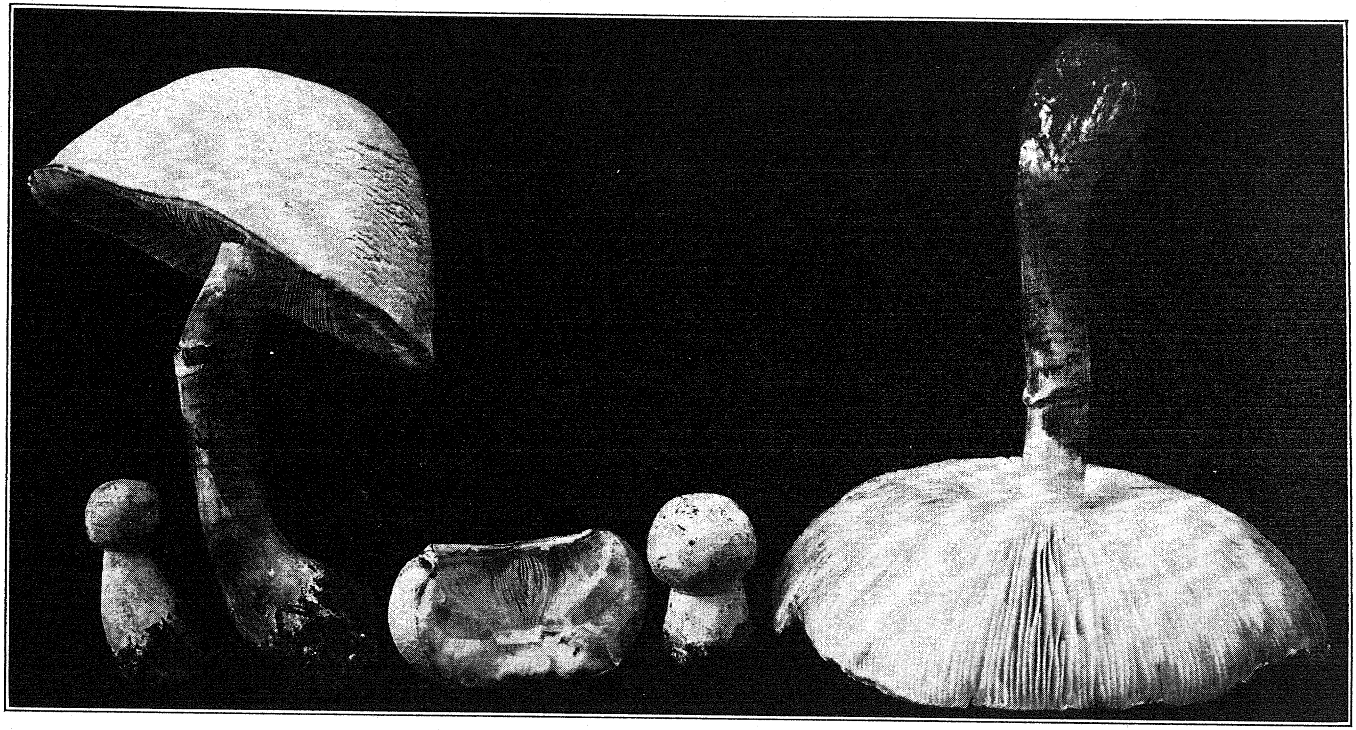
poisonous. In addition there are some closely related amanitas which are either of known poisonous character or which have long been regarded as suspicious, the examination of which in the laboratory indicates the possession of definite poisonous action upon animals. This action should undoubtedly be ascribed to the amanita-toxin which is present in all these species in small quantities. This group includes *Amanita porphyria* Albertini & Schweinitz, *Amanita strobiliformis* Vittadini, *Amanita radicata* Peck, *Amanita chlorinosma* Peck, *Amanita mappa* (Batsch) Fries, *Amanita morrisii* Peck, *Amanita citrina* Persoon and *Amanita crenulata* Peck. In this group should also be placed *Amanitopsis volvata* (Peck) Saccardo. All these species should be put in the group of deadly poisonous mushrooms by mycologists and be sedulously avoided by collectors (Ford[25]).

POISONING BY AMANITA MUSCARIA LINNAEUS

Botanical features

Poisoning by *Amanita muscaria* or the "fly agaric" is, next to that following the ingestion of *Amanita phalloides,* the most frequent variety of mushroom intoxication. This is primarily due to the great abundance of this species and its wide distribution over the surface of the world. The *Amanita muscaria,* in addition, more than other fungi is subject to great variations in color, size, and markings due to geographical distribution and seasonal changes. This may possibly account for the numerous accidents in America resulting from mistaking *Amanita muscaria* for *Amanita caesarea,* one of our most beautiful and highly prized edible amanitas. Accidents of this nature have occurred most frequently among foreigners, a fact which seems to indicate the closest resemblance between specimens of certain European species and other American species. The following description of *Amanita muscaria* taken from Farlow[26] brings out the essential botanical features of the plant and a little careful observation of growing fungi should enable collectors to distinguish *Amanita muscaria* from *Amanita caesarea* without hesitation. This is especially true in view of the yellow gills and striking white volva of Caesar's agaric.

"The fly agaric (*Amanita muscaria*), so called because decoc-



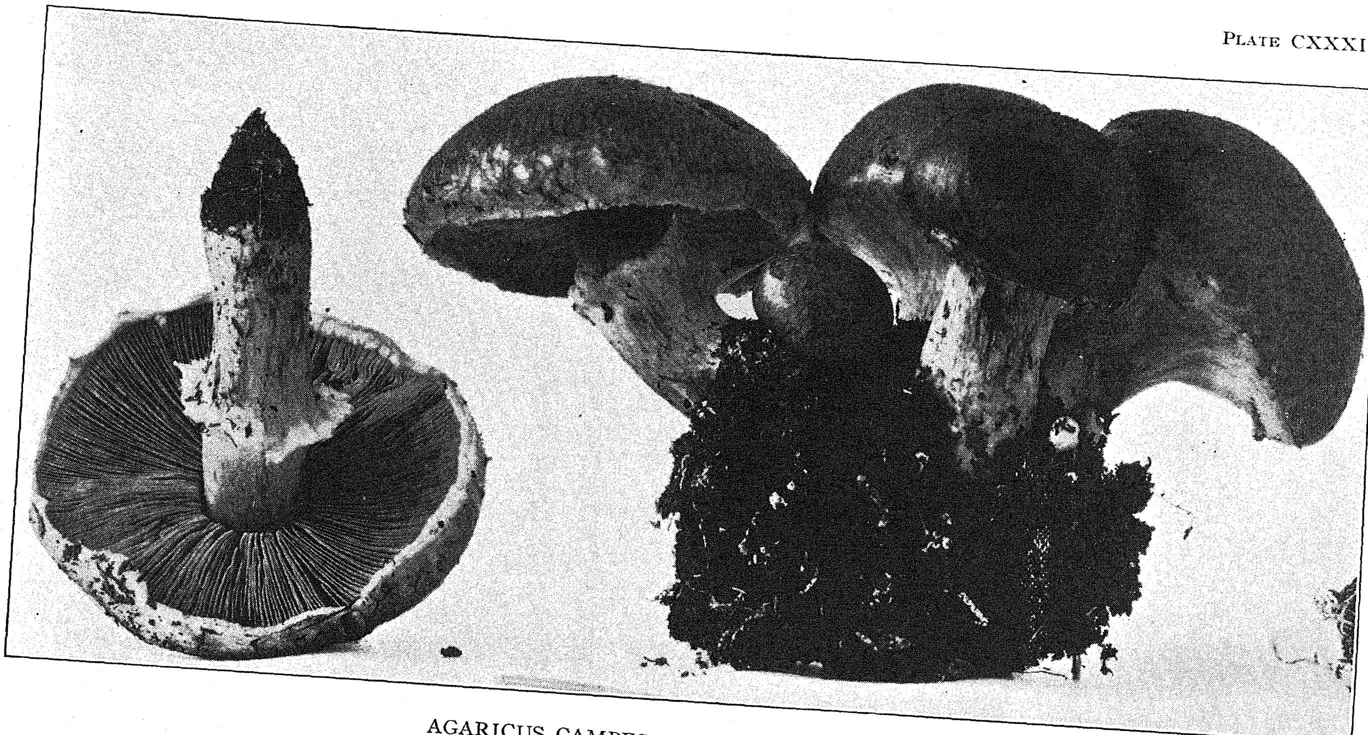
LEPIOTA NAUCINA (FRIES) QUÉL.

tions of it are used in killing flies, is in most places, at least in the northern and eastern parts of the country, a common species—often a good deal more abundant than the common mushroom. It is found during the summer along roadsides, on the borders of fields, and especially in groves of coniferous trees. It prefers a poor soil, of gravelly or sandy character, and occurs only exceptionally in the grassy pastures preferred by the common mushroom. It grows singly and not in groups, and attains a large size, being one of the most striking toadstools. It differs from the common mushroom in having gills which are always white, never pink or purple, and in having a hollow stem which is bulbous at the base and clothed with irregular, fringy scales on all the lower part. The pileus varies in color from a brilliant yellow to orange and a deep red, the yellow and orange being more frequent than the red. The surface is polished [and sometimes sticky], having scattered over it a larger or smaller number of prominent, angular warty scales, which can be easily scraped off. The gills and stalk are white, and there is a large membranous collar, which hangs down from the upper part of the stem."

Clinical aspects

The clinical features of poisoning by *Amanita muscaria* are quite as characteristic as those in *Amanita phalloides* intoxication and should enable physicians to distinguish clearly between the two conditions. Unfortunately, poisonous fungi are usually gathered by the ignorant who sometimes eat a number of different varieties and consequently the symptoms in the patients point to the combined action of different toxic principles. In general, however, there is no difficulty in recognizing the character of the intoxication. In *Amanita muscaria* poisoning there is usually a very short interval between the ingestion of the fungi and the first signs of trouble. This prodromal stage varies from one or two to five or six hours depending upon the amount of the fungi eaten. Careful observation of this feature will frequently be of the greatest value in deciding upon the kind of intoxication which the cases present. In the severe cases the patients show an excessive salivation and perspiration, a flow of tears, nausea, retching, vomiting and diarrhoea with watery evacuations. The pulse may

rarely be quickened, but it is usually slow and irregular. There is no fever. The respirations are accelerated and the patients dyspnoeic, the bronchi being filled with mucus. Mental symptoms are also present, particularly giddiness with confusion of ideas and rarely hallucinations. All these symptoms may vary in their intensity, at some times the gastro-intestinal predominating and at other times the mental. In light cases, where small quantities of the poisonous fungi are consumed, only an excessive salivation or perspiration may be noticed, with uneasiness and discomfort in the stomach and bowels, the symptoms subsiding spontaneously in a few hours. In the severe cases, the vomiting and diarrhoea may be so pronounced as to rid the alimentary canal of the offending material and the nervous symptoms then become the predominant ones. With large quantities of poison also the patients may show the nervous manifestations from the start, delirium, violent convulsions, and loss of consciousness developing in rapid succession and the patients sinking into a coma from which they can be roused with difficulty if at all. Rarely, consciousness is retained till the end, the patients dying from a paralysis of respiration. Finally, in many cases, after the preliminary attack of vomiting and diarrhoea, the patients sink into a deep sleep from which they wake several hours later profoundly prostrated but on the road to recovery. In such cases the effect of the poisoning passes off rapidly, the patients being restored to normal health within two or three days. There are no late effects or after-effects in *Amanita muscaria* intoxication, and the prognosis is always good if the patients recover from the preliminary symptoms. Chronic lesions such as develop in *Amanita phalloides* intoxication and are to be referred to the degenerative changes in the internal organs, do not occur with *Amanita muscaria.*[27] Rarely, the nervous manifestations of "muscaria" intoxication become much more pronounced than the alimentary and the patients become the victims of excitement and hallucinations evidencing many of the symptoms of alcoholic intoxication. This variety of poisoning is particularly common in Siberia where decoctions of *Amanita muscaria* are employed to induce orgies of drunkenness in which the most disgusting practices are followed, according to Kennan.[28] The physiological effect of the Siberian *Amanita muscaria* has



AGARICUS CAMPESTER HORTENSIS COOKE

never been clearly understood and the symptoms shown by the Koraks who employ the fungus as an intoxicant are seldom seen either in Europe or in America. Possibly the method of preserving the plants may alter the poisonous principles in them or possibly the Siberian plants do not contain the same poisonous substances as the European or American varieties. Death, however, is by no means an infrequent occurrence among the Koraks from an overdose of *Amanita muscaria* and, as we shall see later, the active principle of the European plants, muscarin, has also been obtained from the Siberian.

Autopsies upon individuals dead from the ingestion of *Amanita muscaria* have revealed surprisingly little. The pathological changes in the internal organs seen with *Amanita phalloides* are lacking, particularly the hepatic lesions. In general, the findings point to the action of a profound nerve poison (Ford[2]).

Poisonous constituents

As has already been indicated most of the early work upon the poisons in fungi was conducted upon poorly identified plants or upon lots of fungi containing a number of species, and it was not until the middle of the last century that any satisfactory work was accomplished upon *Amanita muscaria*. In 1869 Schmiedeberg and Koppe[29] took up the study of this fungus, investigating its poison from both the chemical and pharmacological standpoint. By the most careful work they showed that *Amanita muscaria* contains an active principle of definite chemical composition which they called muscarin. This was at first regarded as an alkaloid of the same general nature as strychnin and morphin but later work has shown that it is probably a complex ammonia derivative. Muscarin is an extremely active substance and is present in the fungus in but small amounts. Nevertheless, it is able to exert its characteristic effect, frequently with fatal outcome. Its principal action is upon the various organs of the body through the nervous system. It produces an increased secretion from the mucus membranes and from various glands, for instance, by its stimulation of the terminal filaments of the secretory nerves, and at the same time a paralysis of the heart and respiration by a corresponding stimulation of the inhibitory nerve endings of the

vagus nerve. Atropin by its depressing action upon the same nerves which muscarin stimulates, is a perfect physiological antidote for the muscarin found in *Amanita muscaria* and also for synthetic muscarin which may be prepared by the oxidation of cholin. Its use, therefore, was at once suggested in *Amanita muscaria* poisoning.

The work of Schmiedeberg and Koppe upon *Amanita muscaria* was not accepted at once, nor did it fail to arouse considerable opposition. The cases of poisoning by this fungus presented such varied symptoms that it did not seem possible that they could all be referred to the one substance muscarin and this was particularly true in regard to the Siberian *Amanita muscaria*. It was soon shown by Schmiedeberg,[30] however, that the Russian fly amanitas had the same action upon animals as the European type and he was able to isolate muscarin from them. In addition to muscarin, however, Schmiedeberg[31] found later in this fungus evidences of another substance differing from muscarin in producing a dilatation of the pupils, thus acting like atropin. This second substance Schmiedeberg called muscaridin, and he believed that its presence in *Amanita muscaria* in greater or less amount would modify the action of the muscarin and thus the differences in intensity of the symptoms in *Amanita muscaria* poisoning would be explained. Muscaridin was later named "pilz-atropin" by Kobert[32] who states that it can be separated from commercial muscarin by its solubility in ether. It has, however, never been isolated from fresh *Amanita muscaria* plants. Finally, Kunkel[33] and other authorities maintain that the differences shown by the various cases of *Amanita muscaria* intoxication are due to the presence in the plant, in addition to muscarin, of a mixture of chemically related substances having entirely different pharmacological effects. This would account for the fact that atropin does not wholly neutralize the toxic action of *Amanita muscaria* upon animals despite the fact that it is a perfect physiological antidote for muscarin itself. This led Harmsen[34] to take up the question again and he has recently been able to show that extracts of *Amanita muscaria* are twice as toxic weight for weight as pure muscarin, and contain a poison which produces in animals long continued convulsions with a fatal outcome, this effect not being

neutralized by atropin. This poison Harmsen calls the "pilz-toxin." Its presence in *Amanita muscaria* has never been confirmed but some of the evidence, clinical and otherwise, indicates that muscarin may not be at all times the sole poison in *Amanita muscaria.*

It should be noted in this connection that the term muscarin is not the name of a specific chemical substance, but of a group of at least five substances with the same formula $C_5H_{15}NO_2$ and that the effects of these various compounds upon the animal organism are quite different from each other.* A complete discussion of the various muscarins, their properties and manner of preparation may be found in the works of Zellner[35] and Kobert.[32]

Treatment

The outlook in poisoning by *Amanita muscaria* is more hopeful that when *Amanita phalloides* has been ingested, because of the lack of chronic and degenerative lesions produced by the latter species. *Amanita muscaria* causes an acute intoxication which comes on soon after the ingestion of the fungus, develops rapidly, and is amenable to treatment. As we have indicated above, atropin is a perfect physiological antidote for muscarin. Whenever, therefore, the patients show evidence of muscarin poisoning such as lacrymation, salivation, contraction of the pupils, delirium, hallucinations, and coma, atropin should be administered at once and in large doses. At the same time the stomach and bowels should be emptied of the ingested material by the free use of emetics and purgatives. Even though the vomiting and diarrhoea are pronounced, drugs should be employed to increase this action since it is essential that all the fungi be removed and the absorption of poison be prevented. In refractory cases with bad heart action, respiratory distress and coma, atropin should be administered

* The bases cholin and neurin are closely related to muscarin and have both been reported in mushrooms. Neurin is very poisonous. According to Harnack (Arch. exp. Path. u. Pharmacol., 4, pp. 82 and 168 (1875)) the amanitin of Letellier and Speneux[17] is cholin. Clark and Kantor[49] found cholin in *Amanita muscaria* and other fungi. Hofmann (Dissertation, Zurich, 1906) discovered neurin in *A. muscaria,* but it is not certain whether it exists as such in the fungus or whether it is produced by processes of decomposition. The deadly prussic acid has been found in *Marasmius oreades* and *Clitocybe infundibuliformis* by Offner (Bull. Soc. Mycol. de France, 27, 242, 1912).

intravenously. In such cases atropin, indeed, offers the only hope of saving the patient's life. If the symptoms seen in cases of fungus intoxication do not point clearly to muscarin as the chief cause of the trouble but rather to other poisonous principles such as the pilz-atropin of Schmiedeberg and Kobert atropine naturally should not be administered. Finally, whenever the patients show symptoms referable to such poisons as Harmsen's "pilz-toxin" stimulants should be freely administered to tide the patients over periods of weakness and depression.

AMANITA PANTHERINA De Candolle

Amanita pantherina is a common amanita in Europe, particularly in France and Germany where it is regarded as a deadly poisonous species. Boehm[36] has isolated muscarin from this plant in Germany so that the active principle is probably the same as that of the "muscaria." The species is very common in Japan and Inoko[7] believes that it represents *Amanita muscaria* there. Poisoning is quite frequent in that country from its accidental consumption but the symptoms are by no means the same as with the true "muscaria." Delirium and hallucinations with visions of beautiful vari-colored objects predominate over the gastro-intestinal symptoms, the effects being a little like those described for the Siberian "muscaria." The "pantherina" is also said to be used in Japan to produce mushroom drunkenness. Inoko has isolated muscarin from the Japanese *Amanita pantherina* and has also found in it a substance like the "pilz-atropin" of *Amanita muscaria*. *Amanita pantherina* is not common in America but Atkinson[37] believes that his species *Amanita cothurnata* may represent a light colored form of "pantherina" here. In the only report upon *Amanita pantherina* thus far published in America (Ford and Sherrick[38]) no evidence was presented to show that our species contains muscarin. For the present both the real "pantherina" and Atkinson's "cothurnata" should be avoided by collectors. Should symptoms of muscarin intoxication follow their ingestion, the treatment should be along the lines already indicated, namely, complete evacuation of stomach and bowels and large doses of atropin.

EDIBLE AMANITAS

Certain varieties of amanitas have long been known to be edible and indeed have been highly prized by epicures. The most important species of this character are *Amanita caesarea* (Caesar's agaric), *Amanita rubescens* Persoon and *Amanita junquillea* Quelet. No report has appeared in the literature in regard to the chemical properties of *Amanita caesarea* but Ford[39] has shown that *Amanita rubescens* has no toxic action upon animals. *Amanita junquillea* likewise is free from poisonous properties (Ford and Brush[40]). Such species, while possibly safe in the hands of experts should not be collected by amateurs owing to the difficulty in properly identifying them. There are also a number of amanitas which have no poisonous action upon animals, the properties of which have not been clearly established by experience. Among such species are *Amanita frostiana* Peck (Ford[25]) and *Amanita solitaria* Bulliard (Ford[39]). Owing to the resemblance of *Amanita frostiana* to *Amanita muscaria* and to the difficulties in the recognition of *Amanita solitaria* it would be unwise to recommend either of these species. Much the same may be said of *Agaricus amygdalinus* Curtis possibly identical with *Agaricus fabaceus* Berkeley which causes unpleasant symptoms on ingestion but which has never been reported as causing serious illness (Ford and Sherrick[38]).

LEPIOTA MORGANI Peck

The "green-spored" lepiota is a handsome plant growing with great freedom in the Ohio valley. In its favorite localities *Lepiota morgani* thrives in grassy pastures as well as in woods and this fact has been the cause of confusing it with the edible *Agaricus campestris*. The green spores of this fungus ought to serve as a sufficiently striking characteristic to prevent mistaking it for any edible fungus. Chestnut[41] has collected evidence that showed that *Lepiota morgani* often has caused serious illness and at least one death. His physiological experiments indicated that specimens of this plant from the District of Columbia were definitely poisonous to animals and that heating destroyed the greater part of its toxic properties.

CLITOCYBE ILLUDENS Schweinitz

There has always been a tradition that this species is poisonous and not pleasant to eat. Several cases of poisoning from its consumption are recorded but it seems not to have caused fatal results. *Clitocybe illudens* grows in clumps at the base of tree trunks where its bright orange-brown color and phosphorescent glow at night seem to have attracted unfavorable attention. Ford[42] has reported that this fungus produces an acute intoxication in guinea pigs and that boiling the extracts of the plant seems to destroy the toxic properties as is sometimes the case with *Amanita muscaria.* Recently Clark and Smith[11] have investigated *Clitocybe illudens* and have found that upon the exposed frog heart it exerts a typical muscarin effect, which is neutralized at once by the application of atropin solutions. On the whole we may safely say that *Clitocybe illudens* is a dangerous fungus since it contains a muscarin-like substance having a powerful action on the nervous system.

CLITOCYBE DEALBATA SUDORIFICA Peck

The original species, *Clitocybe dealbata* Sowerby, has usually been considered harmless but Peck[43] investigated a reported case of poisoning by it and has found that a form of *Clitocybe dealbata* causes profuse perspiration and discomfort. In consequence, Peck gave this form the varietal name *sudorifica* and advised caution in its use as food. Ford and Sherrick[44] have found that this fungus causes effects upon animals that are nearly identical with those produced by *Amanita muscaria.* As mentioned in the discussion of *Clitocybe illudens,* Clark and Smith have found that *Clitocybe illudens* shows a typical muscarin action also; therefore it seems likely that these two clitocybes may contain nerve poisons nearly as active as muscarin.

LACTARIUS TORMINOSUS Fries

As a general rule, specimens of the genus *Lactarius* are edible but this particular species has always been looked upon askance by mushroom eaters because of the painful gastro-intestinal disorders it causes. Ford[42] has studied its action on animals and has demonstrated that it can produce an acute intoxication with only

a few of the characteristic muscarin symptoms. It is worthy of note that the poison is destroyed by heating, as previously reported by Kunkel.[45] Goldman[46] has reported cases of poisoning by *Lactarius torminosus* in Germany.

RUSSULA EMETICA Fries

The tendency of this brilliant species to cause gastro-intestinal disturbances with vomiting is well known and this reputation has prevented its use as food. Kobert[32] has isolated three basic substances from it; cholin, muscarin, and an atropin-like substance already mentioned in the discussion of *Amanita muscaria*. The emetic properties of this fungus are usually sufficient to cause its expulsion as soon as the material reaches the stomach and thus prevent absorption of the poison.

PHOLIOTA AUTUMNALIS Peck

Peck[47] has called attention to the fact that this supposedly harmless mushroom may be the cause of fatal poisoning and Ford and Sherrick[38] have studied its action on animals and have shown that it is acutely toxic to them. At the autopsy the hearts were found greatly dilated in every case and atropin did not neutralize this peculiar heart-dilating effect. Evidently the poison is a powerful one of unknown nature.

INOCYBE INFIDA (Peck) Earle

This is so small a plant that it is not likely to fall into the hands of mushroom eaters. Murrill,[48] however, has recorded the poisoning of a family of several persons who had eaten *Inocybe infida* by mistake for another similar but edible fungus. Clark and Kantor[49] have isolated from this plant, by methods planned to extract muscarin from *Amanita muscaria*, a small amount of a poison causing long continued paralysis in frogs. The symptoms shown by the frogs were not typical of muscarin but did indicate a definite and powerful action on the nervous system. In a later series of experiments Clark and Smith[11] applied the same extraction methods to both *Inocybe infida* and *Clitocybe illudens*, obtaining substances which had a characteristic muscarin effect upon the frog's heart, the effect being neutralized by atropin. Further

investigations are needed upon these fungi to determine more clearly the relationship of their toxic principles to those found in *Amanita muscaria.*

INOCYBE INFELIX Peck

While this plant has never been investigated from the standpoint of edibility, it has been shown by Ford[42] that it contains a definite poison for both rabbits and guinea pigs, which resists desiccation and boiling. In these animals the fungous extract in small doses produced a deep sleep from which they awoke in a few hours apparently well, while with large doses profound and acute intoxication developed from which they died in a short time. The animals did not show the characteristic "muscaria" effects and Ford was therefore led to conclude that *Inocybe infelix* contained a narcotic poison of some sort. Further work is required in regard to the qualities of this species, particularly since the symptoms noted in the poisoned animals are not entirely inconsistent with muscarin poisoning.

INOCYBE DECIPIENS Bresadola

This fungus has not thus far been tested for edibility, but it has been shown by Ford and Sherrick[38] that it contains a poison belonging to the muscarin-pilocarpin series. In large animals it causes an acute intoxication resembling that produced by *Amanita muscaria* with lacrymation, salivation, contracted pupils, and labored respiration as the chief symptoms. Upon the frog's heart the fungus extracts had the typical "muscaria" effect causing a stoppage in diastole which was neutralized by atropin. *Inocybe decipiens* should, therefore, be grouped with the deadly poisonous fungi, as liable to contain muscarin.

THE HEBELOMAS

Kobert[50] states that both *Hebeloma rimosum* and *Hebeloma fastibile* contain muscarin-like poisons, the nature of which is unknown. Mycologists have usually regarded the genus Hebeloma as unfit for food. At the present time little is known of American specimens of this group, either from the systematic or toxicological standpoint.

THE ENTOLOMAS

In Europe, both *Entoloma lividum* and *Entoloma sinuatum* are classed among the poisonous fungi. According to a recent collection of cases by Sartory[12] in France, *Entoloma lividum* is an extremely dangerous fungus, causing severe illness and occasionally death. Sartory believes that *Entoloma lividum* is nearly as poisonous as some of the various forms of *Amanita phalloides.*

THE PANAEOLUS SPECIES

In this group, *Panaeolus papillionaceus* and *Panaeolus retirugis* are reputed to produce hilarity and a mild intoxication in man. Ford[42] has studied an American form of *Panaeolus retirugis* and has found it to be poisonous to guinea pigs, producing in them a peculiar kind of intoxication which resulted in death but left no lesions apparent at autopsy.

BOLETUS LURIDUS Schaeffer

Among the usually harmless Polyporaceae this species has always had an unsavory reputation. Boehm[36] has isolated muscarin from *Boletus luridus* and has thus shown that there is good ground for including this boletus among the poisonous fungi. *Boletus luridus* is not a common plant in America and may not exist here at all in the form found in Europe.

BOLETUS SATANUS Lenz

Besides the *Boletus luridus* just mentioned it is likely that *Boletus satanas* also contains a poisonous principle. Utz[51] found a basic substance in this fungus and named it boletin but from its chemical properties and its physiological action we may conclude that he probably was dealing with muscarin. Like *Boletus luridus* it is uncertain whether this species occurs in America. It is often said that one is never in danger from eating any boletus but the possibility of muscarin occurring in some of this group is enough to cause one to use caution in eating unfamiliar species, even if nothing worse than gastro-intestinal disturbances are produced.

BOLETUS MINIATO-OLIVACEUS Frost

In 1899 Collins[52] reported cases of poisoning from eating *Boletus miniato-olivaceus* variety *sensibilis* but nothing more was learned of this species until recently when Ford and Sherrick[44] made experiments with it. They showed that extracts from the plant killed guinea pigs in several days but that rabbits were not affected. The guinea pigs became emaciated but nothing characteristic was noted at autopsy.

POLYPORUS OFFICINALIS Fries

From this polypore a definite poisonous substance has been isolated, having the name agaricinic acid, and the chemical formula $C_{14}H_{27}OH(COOH)_2$. This substance is used to a small extent in medicine to lessen excessive perspiration but cannot be given in large doses as it causes vomiting and purging by its strong irritating effect upon the mucous membranes. Jahns[53] and also Hofmeister[54] have made careful studies on the preparation and the physiological action of agaricinic acid.

GYROMYTRA ESCULENTA FRIES

Years ago the poisoning from the false morel was reported frequently in Germany but within the past few years the only note of such accidents is that of Lövegren[55] who has described several cases in which the lesions pointed to a hemolytic intoxication. The action of this fungus upon man and upon animals is by no means definite, however, and much work must be done before the matter is clarified. The European variety of the false morel, *Morchella esculenta* or *Gyromytra esculenta,* has been shown by the researches of Boehm and Külz[56] to contain a hemolytic poison, helvellic acid, and this agrees with the observations which have been made clinically. Accidents from poisonous morels have not been reported in America and no observations have thus far been made with this fungus collected in America except on one occasion (Ford and Sherrick[38]) when it was found to have no hemolytic action or poisonous effect upon animals.

PROPHYLAXIS

Mushrooms are usually eaten for their flavor which makes them an agreeable relish and food-accessory rather than a staple article

of diet. There is no general cook-book test to distinguish the dangerous fungi from the edible ones. The habits and appearance of the poisonous species must be studied until one may recognize them with the same ease and certainty as any of the common plants of our gardens. Neglect of this precaution in gathering mushrooms for the table will sooner or later cause a typical attack of poisoning, and in such cases it should be remembered that the mortality is often as high as in any of the most fatal diseases. The rapidly increasing number of deaths in this country from mushroom poisoning shows that some effort must be made to disseminate exact information about the dangerous species in order to prevent unnecessary suffering and death.

There is a tradition in this country and Europe that treating *Amanita muscaria* (Coville[57]) with vinegar and salt water removes the poisonous constituents. This treatment if repeated several times would probably remove muscarin and similar substances but the danger from incomplete extraction of the poison is still too great to recommend its use. In the case of *Amanita phalloides,* Radais and Sartory[58] have shown that such treatments do not reduce the toxicity of the fungus in spite of popular belief to the contrary. There is little doubt that in some countries people habitually eat *Amanita muscaria* in small quantities, both treated and untreated, with no apparent signs of poisoning, but this does not warrant us in ever allowing ourselves to experiment upon the edibility of such poisonous fungi. Generally, in this country, no one eats *Amanita muscaria* because of its well known dangers. In some of our investigations (Clark and Smith[11]) on American specimens of this plant from different localities we found apparently great differences in toxicity, possibly due to local variation. Furthermore, under certain conditions, heat may destroy the poisons in *Amanita muscaria* as reported by Ford[42] and others, but neither does this observation warrant us in concluding that the dangers from eating this fungus are overestimated.

The first necessary prophylactic measure is to impress upon mushroom lovers that *there is no easy empirical test to distinguish between the edible and poisonous fungi.* No one should eat an unfamiliar mushroom until it has been identified as a harmless species by a well-trained mycologist. It is not difficult to learn

to know fungi at a glance if one is willing to study them closely and to remember the points of difference in form, color, and habit among the various species. Unfortunately, there are a few "mushroom handbooks" in this country, which are unfailing sources of misinformation, and they have evidently been written by people of no training and poor judgment. In one case, color plates of *Amanita muscaria* and *Amanita caesaria* have the names of these two species transposed. Identifications based on pictures are dangerous unless the publication of such unreliable books is prevented. After all, the number of poisonous species is very small and when they are eliminated there are still many desirable fungi which are perfectly safe esculents.

So far we have mentioned only the prophylactic measures to be taken in eating wild mushrooms gathered in the fields, but there is a broader phase to be considered; this is the question of mushrooms in the public markets. If these markets are supplied by wild fungi gathered for the purpose it is necessary to see that no poisonous species become mixed with the others. In European countries many of the public markets have an official mushroom inspector, whose duty it is to examine all lots of fungi before they are exposed for sale and to condemn all fungi not known to be entirely harmless to man. With the increasing taste for mushrooms in this country and the larger stocks carried during the season, it may become necessary for us to control our mushroom supply in a similar manner. Several deaths have been caused by poisonous fungi bought in our public markets.

Even the use of cultivated mushrooms does not guarantee immunity from trouble by poisoning since it is believed by several investigators that harmless fungi may become poisonous if kept too long before consumption (Kobert[59]). This often happens in markets and restaurants where mushrooms become slightly decomposed before they can be sold. Another danger is that cooked mushrooms may develop toxic properties after being kept during the summer weather and again served at subsequent meals (Frey[60]). On chemical ground it is easy to see that the unstable nitrogenous substances in edible fungi could easily be changed into toxic constituents by the action of microörganisms. This is another matter that ought to be studied by chemical and pharma-

cological methods before we can feel at all satisfied with our present knowledge of the properties of poisonous mushrooms.

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STUDIES IN NORTH AMERICAN PERONOSPORALES—VI. NOTES ON MISCELLANEOUS SPECIES

Guy West Wilson

(With Plates 135 and 136, Containing 22 Figures)

Kawakamia Miyabe; Miyabe & Kawak. Bot. Mag. Tokyo 17: (306). 1903

This genus was established for the *Cyperus*-inhabiting species, *Peronospora Cyperi.* This fungus which is a native of Japan has been collected once at Pierce, Texas, on imported plants of its host, *Cyperus tegetiformis* Roxb. According to its author the genus is closely related to *Phytophthora.* Through the courtesy of Mrs. Flora W. Patterson the writer was enabled to make a careful study of both American and Japanese material of the species in the herbarium of the Bureau of Plant Industry. While the measurements of the American specimens are slightly larger than those of the Japanese, there is no question as to their identity. The conidia present a striking likeness in outline to those of *Phytophthora,* but the pedicel is more conspicuous than in any species of this last genus.

The genus *Kawakamia* appears to the present writer to agree more closely with *Basidiophora.* In *Basidiophora* the conidiophore is much enlarged at the apex, and bears a number of cylindric branches on each of which a large, oval, papillate is produced. This conidium breaks away with a portion of the so-called basidial branch adhering as a pedicel-cell much as in the case of the teliospores of the Uredinales. In *Kawakamia* the conidiophore is somewhat different, but strikingly similar. The conidiophore is simple and bears a single conidium on a portion of the conidiophore which is differentiated from the remainder of the hypha both in size and structure. In appearance and structure the fertile portions of the conidiophores both of *Basidiophora* and of *Kawakamia* are similar. In each genus the conidia fall away with the pedicel-cell attached. As these characters are so similar in the

two genera we may characterize *Kawakamia* as *Basidiophora* without the apical clavate enlargement of the conidiophore which bears one instead of several conidia.

PERONOSPORA BORRERIAE Lagerh.; Pat. & Lagerh. Bull. Soc. Myc. France 8: 123. 1892

Like many of the other species of fungi which Professor Lagerheim collected in Ecuador the present one appears not to have been reported from additional localities. Nor is this the only point of interest in connection with this species, as it is neither a *Peronospora* in the strict sense of the word, nor does its host belong to the genus *Borreria*. Although the original description calls for dichotomously branched condiophores the specimen in the Ellis collection at the New York Botanical Garden shows only monopodially 4–5-times branched condiophores with the pronouncedly conic and narrowly pointed ultimate branchlets which are so characteristic of that section of the genus *Rhysotheca* which contains the species *R. Viburni, R. ribicola,* and *R. Gonolobi.* Indeed it approaches the last named species quite closely in both size and habit. The conidia are also nearest to those of that species, but their ovoid outline readily distinguishes them from those of any of the other species just mentioned. The present species should stand next to *R. Gonolobi.* An examination of the host shows it to be *Mitrocarpus hirsutus* (L.) DC., a species common throughout tropical America. We may, therefore, look for future collections of this fungus from other localities. The species should be known as **Rhysotheca Borreriae** (Lagerh.) G. W. Wilson.

RHYSOTHECA HELIOCARPA (Lagerh.) G. W. Wilson Bull. Torrey Club 34: 402. 1907

This species was described by Lagerheim from Ecuador on *Heliocarpus.* So far as the present writer has been able to learn it has not been reported in any subsequent paper. It was with considerable pleasure and surprise that a packet of material from Cuba from the collections in 1903 by the late Professor L. M. Underwood and Professor Earle was examined and found to be this species. The material was collected at the base of El Yunque

Mt., Baracoa, during the month of March. The host is a species of *Triumfetta*, apparently *T. Lappula* L., a species which was also collected in the same region. The Cuban material is slightly more slender than the Ecuadorian, but is otherwise the same.

Pseudoperonospora Humuli (Miyabe & Takah.) nom. nov.

Peronoplasmopara Humuli Miyabe & Takah. Trans. Sapporo Nat. Hist. Soc. **1**: 153. 1907.

Pseudoperonospora Celtidis Humuli Davis, Science II. **31**: 753; (hyponym). 1910.

Plasmopara Humuli Miyabe & Takah. in Sacc. & Trott.; Sacc. Syll. Fung. **21**: 861. 1912.

This species first attracted attention by a serious outbreak in the hop-fields in the Province of Sapporo, Island of Hakkaido, Japan. It was later collected on the wild hops of the same island as well as on those of the Island of Honshu. Some years later Doctor Davis collected a fungus on the wild hops of Wisconsin which he considered quite close to *P. Celtidis,* but entitled to subspecific rank. Through the kindness of Mrs. Flora W. Patterson the writer has been able to examine Japanese material of this species and to compare it with specimens submitted by Doctor Davis. As in the case of *Kawakamia Cyperi* the measurements of the American material do not agree exactly with those of the Japanese specimens, but otherwise the similarity is too great to admit a question of their identity.

PERONOSPORA ERODII Fuckel. Fungi. Rhen. *2102*. 1867—
Symb. Myc. 68. 1869

This species was issued by D. Saccardo in his Mycotheca Italica *890* as *Plasmopara Erodii* (Fuckel) D. Sacc. A note on the label states that in as much as the form on *Erodium* produces conidia which germinate by zoöspores it cannot be considered identical with *Peronospora conglomerata* Fuckel, on *Geranium*, to which European mycologists usually refer it. The correctness of this observation is further supported by the form of the conidia and the type of the conidiophores which indicate that the species is a member of the genus *Pseudoperonospora* and should be known as **Pseudoperonospora Erodii** (Fuckel) G. W. Wilson.

Bremiella gen. nov.[1]

Conidiophores from the stomata, the branches few and quite long, the main axis breaking up dichitomously or pseudo-monopodially, the ultimate branchelets quite long and terminating in an apophysate enlargement; conidia papillate, basially constricted and somewhat pyriform, hyaline, germinating by zoöspores: oöspores conspicuously wrinkled, free in the oogonium.

Type, *Peronospora megasperma* A. Berlese.

The downy-mildew of the violets of Europe and of America are two very distinct fungi which should never have been confused. *Peronospora Violae* De Bary is a typical member of the genus. The American form, which was first recognized as a distinct species in 1899 and named *Peronospora megasperma,* is such an anomalous form that the same author later transferred it to the genus *Plasmopara.*

Apparently the first collection of the American species was made in April 1882 by Professor F. S. Earle, who supplied material to Ellis for his North American Fungi. Of this material Doctor Farlow writes "The specimens received from Mr. Earle were collected in April 1883 (sic), and can be referred without doubt to this form their resemblance to *P. effusa* var. *minor*"[2] A note in a packet of this same collection in the Earle herbarium at the New York Botanical Garden calls attention to the swollen ends of the conidiophores and credits Professor Burrill with having pointed out the essential differences which we have noted between this and the European species. Upon the same authority the conidia are also said to germinate by means of zoöspores. The conflicting evidence leaves it an open question whether or not both of the violet-inhabiting species occur in America. It appears, however, from an examination of the material at hand that in all probability we have in America only one species. This we have designated **Bremiella megasperma** (A. Berlese) G. W. Wilson.

1 Hyphis conidiophoris solitaris vel fasciculatis, e stomatibus plantarum erumpentibus, dichotomo-vel pseudo-monopodio-ramosis; ramuli terminalis longis, apice in vesiculam apophysatam abientibus; conidis hyalinis, pyriformibus, apice papillatis, per zoosporas evacuantia; oosporis subrugosis.

2 Bot. Gaz. **8**: 328. 1883.

PERONOSPORA DESTRUCTOR (Berk.) Casp.; Berk. Outl. Brit. Fung. 349. 1860

Botrytis destructor Berk. Ann. Mag. Nat. Hist. II. 6: 436. 1841.
Peronospora Schleideni Unger, Bot. Zeit. 5: 315. 1847.
Peronospora Schleideniana Unger: De Bary, Ann. Sci. Nat. IV. 20: 122. 1863.

The synonymy of this species has been discussed briefly by Professor Whetzel,[3] but as this author retains the last name in preference to the first it may not be out of place to again call attention to the nomenclatural vicissitudes of the species. First described by Berkeley as *Botrytis destructor* the same author later lists it under *Peronospora,* citing the earlier synonym, and crediting the combination to Caspary, probably in recognition of some manuscript name. Meantime Schleiden found the same species in Germany and figured it with a brief description, calling it *Botrytis (parasitica?)*[4] This forms the basis of *Peronospora Schleideni* Unger, which was later amended to *P. Schleideniani* in De Bary's revision of the group. While the weight of this authority has given the latter name wide usage, the older one is the proper designation of the species.

PERONOSPORA ARENARIAE MACROSPORA Farl. Bot. Gaz. 9: 38. 1884. Not *Peronospora macrospora* Unger. 1847

Of the six species of *Peronospora* which infest members of the pink family three have tuberculate oöspores. Two of these species are European, *P. Dianthia* De Bary being found on species of *Dianthus, Agrostemma,* and *Lychnis* and *P. Arenariae* De Bary on *Arenaria* and related genera, while the third is an American species on *Silene.* In 1884 Professor Farlow first called attention to the American species, pointing out its intermediate position between the two European species just mentioned and giving it a varietal position under the later of these. An examination of American material and a comparison with both of the foreign species has convinced the writer that the form under consideration is entitled to specific rank. While the oöspores are larger than those of *P. Arenariae* they are otherwise quite similar. The

[3] Bull. Cornell Agr. Exp. Sta. 218: 149. 1904.
[4] Grundz. Wiss. Bot., ed. 3, 2: 37. *f. 106.* 1849.

conidiophores are also more like those of *P. Arenariae*, but suggesting somewhat *P. Dianthi*. This last species, however, is somewhat stouter than the others. The conidiophore of the American species is somewhat more branched than *P. Arenariae* and has much more slender ultimate branchlets than does the European species. As the varietal name is untenable for a species in the genus this fungus may be renamed **Peronospora Silenes** G. W. Wilson.

PERONOSPORA PARASITICA (Pers.) Fries AND ITS SEGREGATES

While it has been customary to consider any collection of *Peronospora* on a Cruciferous host as certainly belonging to *P. parasitica* a very wide range of variation has been allowed in the characterization of the species. True, various names have been applied, especially by the earlier authors, to the fungus as it appears on various hosts. The majority of these names, however, represent what may be termed "host species," *i. e.,* their chief distinguishing characteristic is their host.

The first valid segregation by an European mycologist was based on an error in the determination of the host. The case in point is *P. Niessleana* A. Berlese, based on a specimen in the herbarium of Niessl which was labeled *P. Phyteumis* Fuckel, on *Phyteuma,* but evidently not that species. So thoroughly convinced does this author appear to have been that the fungus in question was distinct from other recognized species that when it was found that the host was in reality *Alliaria* he retained the form as a subspecies under *P. parasitica.* What appears to be the same species of fungus was figured by Sowerby as *Mucor Erysimi.* Berlese's first judgment was better than his last, as the form is certainly entitled to specific rank.

A careful study of a wide range of specimens has convinced the writer that there is still a third form on the Cruciferae which deserves to be accorded specific rank. The more comprehensive of the published descriptions have recognized a form of *P. parasitica* with comparatively simple conidiophores which have a more open head. This form is quite widespread in America, and from the literature it appears to be common in Europe. A subspecies

has been described from Australia by McAlpine as *P. parasitica Lepidii,* which is based upon essentially the same set of characters. Through the courtesy of Professor McAlpine the writer has been enabled to examine cotype material of the Australian fungus which proves to be in every way identical with the American form.

The synonymy of these species and a description of the third one follows. No account is taken here of *P. crispula* Fuckel, on *Reseda* in Europe, which has frequently been referred as a synonym to *P. parasitica,* but which is certainly to be regarded as a valid species.

1. PERONOSPORA PARASITICA (Pers.) Fries, Sum. Veg. Scand. 493. 1849

Botrytis parasitica Pers. Obs. Myc. 1: 96. 1796.
Mucor Botrytis Sow. Eng. Fungi *pl. 359.* 1802.
Botrytis nivea Mart. Fl. Crypt. Erlang. 342. 1817.
Peronospora ochroleuca Ces. in Rab. Herb. Viv. Myc. II. *175.* 1855.
Peronospora Dentariae Rab. Fungi Europ. *86*—Flora **42**: 436. 1859.
Peronospora Botrytis Cocconi & Morini, Mem. Acad. Sci. Ist. Bologna IV. **6**: 394. 1885.

2. PERONOSPORA NIESSLEANA A. Berlese, Icon. Fung. Phyc. 40. *pl. 66, f. 1.* 1898

?Mucor Erysimi Sow. Eng. Fungi *pl. 400, f. 7.* 1803.
Peronospora parisitica Niessleana A. Berlese, Icon. Fungi Phyc. 41. 1898.

3. **Peronospora Lepidii** (McAlp.) sp. nov.

Peronospora parasitica Lepidii McAlp. Proc. Royal Soc. Victoria 7: 221. 1895.

Hypophyllous or caulicolous, covering the irregular and more or less indefinite infected area with a dense white growth; conidiophores 3–8 from a stoma, 130–223×4–9 μ, 3–8 times branched, the primary branches erect, the ultimate branchlets straight or somewhat recurved, arising at acute angles, about 3×8 μ; conidia broadly ellipsoid or almost globose, 15–23×18–35 μ, hyaline; oögo-

nia with a thick, yellowish membrane which does not collapse; oöspores subglobose, 25–50 μ, epispore yellowish-brown, wrinkled.[5]

ON BRASSICACEAE:

Arabis virginica (L.) Trel., Alabama, *Underwood.*
Bursa Bursa-pastoris (L.) Britton, Kentucky, *Kellerman.*
Coronopus didyma (L.) J. E. Smith, North Carolina, *Wilson.*
Lepidium apetalum Willd., Iowa, *Wilson;* Nebraska, *Sheldon.*
Lepidium Virginicum L., Illinois, *Seymour* (Econ. Fungi *258a*); Kansas *Bartholomew* (Fungi Columb. *2129*); Kentucky, *Kellerman* (Fungi Europ. *2870,* N. Am. Fungi *1460b*); New Jersey, *Halsted* (Econ. Fungi *258b*); North Carolina, *Stevens.*
Lepidium sp., Idaho, A. A. & E. G. Heller, *3020.*
Roripa palustris (DC.) Bessey, Iowa, *Hitchcock.*
Roripa sp., Alabama, *Underwood.*
Sophia sp., Colorado, *Bethel.*

DISTRIBUTION: New Jersey to Alabama and Colorado. Also in Australia, and probably in Europe.

TYPE LOCALITY: Ardmona, Victoria, Australia, on *Lepidium ruderale* L.

The three species on Cruciferous hosts may be briefly characterized as follows: *P. parasitica,* with much branched conidiophores, the branches forming a dense tangled head, *P. Niessleana* having an open headed conidiophore which branches 2–4 times, the branches widely spreading and with the extremities rather recurved, *P. Lepidii* with the main branches of the conidiophore ascending, but not forming a dense head as in *P. parasitica.*

PERONOSPORA SCHACHTII Fuckel, Fungi Rhen. *1508*—Symb. Myc. *71.* 1869

This species, which is readily distinguished from the others which inhabit Chenopodiaceous hosts by the straight branches of

[5] Hypophyllis vel caulicolis, caespitulis densis, albis; conidiophoris 3–8 fasciculatis, 130–223 × 4–9 μ, 3–8-ies ramosis, ramis inferioribus rectis, angulato-divergentibus, penultimis et ultimis subulatis, acutangulo-divergentibus, rectis vel saepius recurvatis, subaequalibus, circa 3 × 8 μ; conidiis late ellipticis vel fere globosis, 15–22 × 18–35 μ, hyalinis; ooginis e tunica crassa, pallide-lutea, persistenti formatis 35–60 μ; oosporis subglobosis, 25–50 μ, episporis luteo-bruneis, rugosis.

its conidiophores, has recently appeared on the sugar beet in California. So far as recorded the species appears to be known only on cultivated beets, except in Portugal where Professor Lagerheim found it on the wild *Beta marina*. Fortunately from the agricultural standpoint the fungus does not seem to thrive as well in our climate as have some other imported forms. It is to be hoped that it may not prove a serious pest here.

PERONOSPORA EFFUSA (Grev.) Ces.

This name has been applied very loosely to various members of the genus *Peronospora* from hosts of several widely separated families, but in recent years the name has been restricted to the *Peronospora* on Chenopodiaceous hosts other than the genus *Beta*. Two forms of *P. effusa* are usually recognized by mycologists, but there is such wide diversity in the application of the names that the material referred to var. *minor* by one author is called var. *major* by another. While the taxonomic history of the species is not long in list of names the earlier descriptions were drawn up at a time when "brevity was indeed the soul of wit."

The description of *Botrytis effusa* Grev. is accepted as the starting point of the history of the species. This name was proposed for a parasite of *Spinicia oleracea* in Scotland. The fungus was figured a few years later by Desmaziers[6] who represents the divaricate form on spinage. He also adds *Atriplex, Chenopodium, Urtica* and *Rhinanthus* to the list of hosts and makes a query as to whether or not *B. effusa* Grev. and *B. farinosa* Fries are identical. The latter species is evidently rather closely related to the former which is not mentioned by Fries. The type of *B. farinosa* came from leaves of *Atriplex,* but older saprophytic species are cited as synonyms.. From the descriptions of these two species of *Botrytis* we may feel sure that the first refers to the *Peronospora* on *Spinicia* and the second to that on *Atriplex.*

The species were transferred to *Peronospora* by Cesati and within a few years other names were added to the synonymy of the species. Schlechtendal had just previously described a species on *Chenopodium hybridum* which he called *Peronospora Chenopodii.* While his description is very indefinite, his material is quite

[6] Ann. Sci. Nat. II. 8: *pl. 1. f. 1, 2.* 1837.

unlike that figured by Desmazières, having flexuose branches with the ultimate branchlets strongly recurved. That is to say, if we adopt the classification proposed by Berlese the material of Greville and Desmazières would fall in the section *intermediate* while that described by Schlechtendal belongs to *divaricatae*. That *Peronospora effusa* presented a wide range of variation was first pointed out by Caspary[7] who recognized two varieties, *α major* being the typical intermediate form of the older authors, while *β minor* on *Atriplex patula* from Bonn is the undulate form..

Recently Laubert[8] discussed the variations within the accepted limits of the species and figured portions of the conidiophores of the two forms. He does not refer to the synonymy of the species nor propose any new name for either form. In the course of the review of this article Detmann removes the typical portion of the species from *Peronospora effusa* and calls it *P. Spinaciae* n. sp.

The most recent pronouncement on the question comes as an echo from the Brussels congress where the assembled botanists of the world in their wisdom decreed that those fungi not otherwise provided for should begin their historical career with Fries's Systema. As this work contains the reference noted above to *Botrytis farinosa* and its saphrophytic habits but does not mention the earleir better defined and strictly parasitic *Botrytis effusa*, Doctor Keissler concludes that it is necessary to take up *Botrytis farinosa* and drop *P. effusa* to the realm of prehistoric nomenclature. He accordingly transfers the name to *Peronospora*, cites the stock synonyms, and then issues in "Kryptogamae exsiccatae" *1829* two specimens, "*a*) Austria inferior: ad folia *Chenopodii albi* L. . . . *b*) Hungaria: ad folio *Chenopodii hybridi* L. . . ." The first of these is *P. farinosa* as treated in the present paper, while the second belongs to the other side of the species.

A careful study of these forms leads to the conclusion that as usually construed *Peronospora effusa* consists of two quite dissimilar species. The complete synonymy as well as the list of hosts from which material was studied follows.

[7] Rab. herb. Viv. Myc. II. cent. 2. *172*. 1855.

[8] Gartenflora **55**: 433–440. *f. 45*. 1906.

1. PERONOSPORA EFFUSA (Grev.) Ces. in Rab. Herb. Viv. Myc. I. *1880*. 1854

Botrytis effusa Grev. Fl. Edin. 468. 1824.

Peronospora effusa α major Casp. Monatsb. K. Preuss. Akad. Wiss. **1855**: 328. 1855.

Peronospora Spinaciae Detmann, Bot. Cent. **105**: 25. 1907.

HOSTS: **America,** *Chenopodium album, C. hybridum, Monolepis Nuttalliana, Spinicia oleracea.* **Europe,** *Chenopodium polyspermum, C. hybridum, Spinacia oleracea.*

Most abundant on *Spinacea oleracea.*

2. PERONOSPORA FARINOSA (Fries) Keissler, Ann. K. K. Naturh. Hofm. Wein **25**: 229. 1911

Botrytis farinosa Fries, Symb. Myc. 3: 404. (Excl. synonymy.) 1823.

Erineum atriplicinum Nestler; Fée, Mem. Phyll. et Erineum 59. 1834.

Peronospora Chenopodii Schlecht. Bot. Zeit. **10**: 619. 1852.

Monosporium Chenopodii Schlecht. Bot. Zeit. **10**: 619. 1852.

?Peronospora Chenopodii Casp. Bot. Zeit. **12**: 565. 1854.

Peronospora effusa β minor Casp.; Rab. Herb. Viv. II. *172*. 1855.

Peronospora epiphylla Pat. & Lagerh. Bull. Soc. Myc. France **7**: 167. p. p. 1891.

HOSTS: **America,** *Chenopodium album, C. hybridum, C. leptospermum.* **Europe,** *Atriplex patulla, Chenopodium album, C. Bonus-Henricus, C. glaucum, C. hybridum, C. Murale, C. rubrum, Spinacia oleracea.* **Asia,** *Chenopodium album.*

Most abundant on species of *Chenopodium* and *Atriplex.*

SPECIES OF PERONOSPORA WHICH INFEST EUPHORBIACEAE

Four species of *Peronospora* have been described from hosts of the family Euphorbiaceae. The first of these was *P. Pepli* Durieu[9] which was found in France on *Euphorbia Peplis* L. While the author does not give a formal description of his plant he speaks of the conidiophores in a way to bear out his statement

[9] Ann. Soc. Linn. Bordeaux **20**: — (13). 1855.

that the fungus is similar to *Botrytis parasitica.* It would appear that he had a species of *Peronospora,* but it is impossible to say which one without seeing material of his collection. In the course of his remarks he refers to the remarkable phenomenon of the same plants also harboring a species of *Erysiphe,* and, to judge from the comments of his contemporaries, the material which he disturbed among them contained only the later fungus.

In 1863 Fuckel issued in his Fungi Rhen. *40* a *Peronospora* on *Euphorbia platyphylla,* naming it *P. Euphorbiae,* and in his monograph of the same year De Bary described another species from *Euphorbia Syparissias* as *P. Cyparissiae.*[10] Through the kindness of Doctor Tranzschel it has been possible to examine material from Fuckel's exsiccati. A comparison of this with authentic material of *P. Cyparissiae* shows them to be distinct from each other as well as from the species to be mentioned later. *P. Euphorbiae* has hyaline conidia, while *P. Cyparissiae* has violet ones. *P. Euporbiae* has slender conidiophores which are 6–8 times branches, the ultimate branchlets rather widely divergent, the branches straightish, and forming a rather close head. *P. Cyparissiae* has a stouter conidiophore with more erect habit, and a closer head, the ultimate branchlets also widely divergent. As the oöspores of *P. Cpyarissiae* are unknown no comparison on this point can be made.

The next species to be described was *P. andina* Speg.[11] from Argentina, which is much smaller than the preceding. The conidiophores are rather small, branching 3–5 times, the branches spreading, the ultimate branchlets rather flexuose, and forming an open head. The conidia are hyaline. The oöspores are unknown.

The North American species of *Peronospora* on hosts of this family has been variously recorded as *P. Euphorbiae* and *P. Cyparissiae.* A close study of the American fungus and a comparison with these European species shows it to differ in several respects from either of them. As our species has violet conidia we can dismiss *P. Euphorbiae* with the remark that its oöspores are more wrinkled than those of our species. Its conidia, while of the same color as those of *P. Cyparissiae* are slightly more

10 Ann. Sci. Nat. IV. 20: 124.

11 Ann. Mus. Nac. Buenos Aires III. 12: 282. *f. 3.* 1909.

rounded, while the conidiophores present still more marked contrasts. In the American species the conidiophores are more branched than in either of the European species, the branches are rather flexuose and incurved, forming a denser head than in either of these species. In our species, the conidiophore branches are more slender and the ultimate branchlets longer than in the European. As this series of differences is sufficient to warrant the separation of our form as a distinct species, a diagnosis follows, under the name *Peronospora Chamaesycis,* as all its hosts belong to this segregate of Euphorbia.

Peronospora Chamaesycis sp. nov.

Hypophyllous, forming a dense bluish felt-like growth on the host, epiphyllous discoloration not prominent, rather chloratic or somewhat yellowish; conidiophores solitary or only two or three from a stoma, 200–450×6–10 μ, branching 6–9 times, the branches elongate, slender, more or less flaccid, and having a tendency to be incurved, more or less flexuose, the ultimate branchlets at right angles, subequal, the axial longer, somewhat subulate, slender, straight, 5–8×2–4 μ; conidia globose to ovoid, 20–28×12–20 μ, violet; oögonia thin walled, yellowish; oöspores 30–40 μ, yellowish-brown, epispore smoothish or more or less wrinkled.[12]

Type, on *Chamaesyce serpens* (H.B.K.) Small, Rooks County, Kansas, E. Bartholemew, Aug. 25, 1902. Issued as Fungi Columbiana *1750*, in the herbarium of the New York Botanical Garden.

ON EUPHORBIACEAE:

Chamaesyce glyptosperum (Engelm.) Small (*Euphorbia glyptosperum* Engelm.), Nebraska, *Bates* (Fungi Columb. *2338*).

Chamaesyce humistrata (Engelm.) Small (*Euphorbia humistrata* Engelm.), Indiana, *Wilson.*

Chamaesyce maculata (L.) Small (*Euphorbia maculata* L.), Illinois, *Conkling;* Indiana, *Arthur Wilson;* Iowa, *Hitchcock, Wilson;* Massachusetts, *Farlow* (N. Am. Fungi *216*); New Jersey, *Ellis.*

[12] Maculis epiphyllis decoloratis, griseo- vel diluto-aureiis; conidiophoris hypophyllis, dense caespitosis, 1–3 e stomatibus erumpentis, 200–450 × 6–10 μ, 6–9-ies ramosis, ramis elongatis, gracilibus, flaccidis, incurvatus, flexuosis, ultimis subequalibus, axilibus longiore, subulatis, rectis, 5–8 × 2–4 μ; conideis globosis vel ovoideis, 20–28 × 12–20 μ, violaciis; oogoniis auriis; oosporis 30–40 μ, aureo-bruneis, episporeis crassis.

Chamaesyce serpens (H.B.K.) Small (*Euphorbia serpens* H.B.K.), Kansas, *Bartholomew* (Fungi Columb. *1750*).
Chymaesyce stictospora (Engelm.) Small (*Euphorbia stictospora* Engelm.), Nebraska, *Bates* (Fungi Columb. *2128*).
DISTRIBUTION: Throughout the northeastern United States.

PERONOSPORA TRIFOLIORUM De Bary, Ann. Sci. Nat. IV. 20: 117. 1863

This species, which has been known in America until recent years as most abundant on certain species of *Astragalus,* has appeared on alfalfa (*Medicago sativa*) in numerous localities from New York to California. In some localities it appears to be of rather slight economic importance, while in others it is reported to cause serious trouble. To judge from the specimens available for study the form on *Medicago* is slightly more slender than that on *Trifolium,* and several times as abundant, even in Europe, on that host as on all the various species of *Trifolium* together. It would appear that the species is made up of races only slightly different from each other morphologically, but with unequal virulence.

PERONOSPORA PLANTAGINIS Underw. Bull. Torrey Club 24: 83. 1897

This is a quite different species from the older and better known *P. alta* Fuckel, which is common in the northern states on *Plantago major* and other broad-leaved perennial species of the genus. The conidiophores of *P. Plantaginis* are a trifle stouter, with a smaller head, and straighter branches, with the ultimate branchlets much smaller. The conidia are also shorter and not so blunt as in *P. alta.* This species is found on *Plantago aristata* from North Carolina to Alabama. In the region of Raleigh, North Carolina, where the writer had the opportunity of studying the fungus in the field it was very abundant, sometimes appearing to be quite injurious to its host.

The oöspores of neither *P. Plantaginis* nor *P. alta* have been described. It is consequently a matter for regret that the specimen on *Plantago pusilla* from Alabama in the Ellis collection has no conidiophores so that the species of *Peronospora* could be de-

termined, as oöspores are present in abundance. They very evidently belong to a species of *Peronospora,* rather than to a Chytridiaceous fungus. They are yellowish-brown, quite large, measuring 60–95 μ across, and have a conspicuously wrinkled epispore.

PERONOSPORA PHLOGINA Dietel & Holway, Bot. Gaz. 19: 306. 1894

Two species of *Peronospora* have been described from hosts of the family Polemoniaceae. The first of these, *P. Phlogina,* was described from material collected by Professor Holway at Decorah, Iowa, on *Phlox divaricata.* The next year *P. Giliae* Ellis & Ev.[13] was described from northern Idaho on an undetermined species of *Gilia.* Such is the uncertainty of matters taxonomic that the host is no longer considered to belong to that genus, but to one of the recent segregates. It accordingly bears the name *Microsteris gracilis* (Dougl.) Greene. While the two species of fungi have found their way into separate sections of the genus *Peronospora* in Berlese's monograph they agree in all essential details. The conidiophores are of the same type, the conidia present less variation than do those of some species of the genus, and all together there does not appear to be more variation than can reasonably be expected in a species, especially one so poorly known. These species, therefore, must be united under the older name.

PERONOSPORA POTENTILLAE De Bary, AND ITS SEGREGATES

While various species of *Peronospora* have been described on widely separated genera of Rosaceae they have, with the exception of *P. sparsa* Berk. on species of *Rosa,* at one time or another been referred to *P. Potentillae.* Three of these species are present in America, and it is with these that we are at present concerned. *Peronospora Potentillae* De Bary, the older of these species, was originally described from material on a species of *Potentilla.* As further collections were made it was found to be prevalent on several other genera of herbaceous Rosaceae. Later two French botanists, Roze and Cornu, described *Peronospora Fragariæ.*[14]

[13] Cont. U. S. Nat. Herb. 3: 276. 1895.

[14] Bull. Soc. Bot. France 23: 242. 1876.

from *Fragaria vesca* in France. This is a very large species, the conidiophores reaching the rather startling height of a millimeter, and branching more profusely than do those of other species on Rosaceous hosts. The conidia, as might be expected, average a little larger also. As the leaves of *Fragaria* and certain species of *Potentilla* which are infected with the fungus are not sufficiently different either in texture or hairiness to account for the wide variation between the fungi on them we are led to conclude that they represent two valid species.

The third species with which we are concerned, *P. Rubi Rab.*[15] was distributed by Rabenhorst on *Rubus fruticosus* from Germany. In the *Rubus*-inhabiting fungus the conidia and conidiophores are nearer the same size as those of *P. Potentillae* than is the case with *P. Fragariae*. However, the two species, similar as they are, are quite readily distinguishable. *P. Rubi* has conidiophores more branched, with longer ultimate branchlets, and a denser head, while the conidia are somewhat broader and darker in color than those of *P. Potentillae.*

From the foregoing comparison we conclude that there are in America three species of *Peronospora* on Rosaceous hosts. These are *P. Rubi* Rab. confined to the shrubby genus *Rubus, P. Fragariae* Roze & Cornu, collected in Iowa on *Fragaria,* and *P. Potentillae* De Bary on various species of *Agrimonia, Geum,* and *Potentilla.* Besides these *P. sparsa* Berk. is found occasionally on *Rosa.*

PERONOSPORA ARTHURI Farlow, Bot. Gaz. 8: 315. 1883

This species, which appears to be rather widespread and somewhat sporadic in its appearance, presents an interesting puzzle to those who follow Schröter and Fischer in dividing the species of *Peronospora* into two groups on the basis of oöspore markings, placing in Calotheca all those species which have reticulate or tuberculate oöspores and in Leiotheca those having smooth or wrinkled oöspores. In the present species the oöspores possess pronounced characters of both these groups, as the epispore is conspicuously wrinkled, and thickly covered with short blunt tubercles.

15 Fungi Europ. *2676* (hyponym) 1881.—Schröt. in Cohn, Krypt. Fl. Schles. 3^1: 250. 1886.

PERONOSPORA TRICHOMATA Massee, Jour. Linn. Soc. **24**: 48. *pl. 1, f. 1.* 1887

The species so designated is described as causing a serious root-rot disease of *Colocasia esculenta* in Jamaica. This subterranean habit is at variance with the usual place of growth of members of this family, all of which are leaf parasites, or at least grow on the aerial parts of the host. The author's figures are not convincing that the fungus in question has been properly referred. It would appear from them that the conidial part of the species belongs to some genus of Hyphomycetes, probably *Verticillium,* and that the oösporic phase belongs elsewhere in the same group. A careful study of material from the herbarium of Professor Massee confirms this view. The species, then, is to be excluded from the genus *Peronospora* and transferred to the Hyphomycetes. As *Phytophora Colocasiae* Rac. is now known to cause a tuber rot in India it is not improbable that this species was the real offender, while the fungi described may have been merely secondary saprophytes.

It is not impossible that the material submitted to Massee was affected by *Phytophthora Colocasiae* Racib., and that this fungus was overgrown by those which he described.

PERONOSPORA NICOTIANAE Speg.

From time to time various alarmist reports have appeared as to the dire consequences of the spread of either the present species or *Phytophthora Nicotianae* Van Breda de Haan into tobacco growing countries other than their native lands. It is accordingly cause for some little surprise that mycologists have so far failed in the majority of cases where they have come in contact with this species to recognize it as the dreaded foe for which they were looking. The history of the species was given in brief in so far as it referred to certain hosts, in a former number of this series.[16] In addition to the cases mentioned in that paper two others deserve mention. Harkness and Moore have recorded *Peronospora sordida* on *Nicotiana Bigelovii* from Nevada. This, with the record by Professor Farlow of *P. Hyoscyami* on *N. glauca* in California, would indicate that *P. Nicotianae* was probably not a formidable

[16] Bull. Torrey Club **35**: 364. 1908.

foe to the American tobacco grower. However evidence comes from a different quarter which is not so quieting. For a term of years serious outbreaks of a seed-bed disease of tobacco plants in Australia caused much loss to the tobacco growers of the colony of Victoria. Material submitted to Professor Massee for identification was pronounced *P. sordida* Berk. a very different species which is confined to certain genera of Scrophulariaceae. However this Australian record is the only one of the species being found on *Nicotiana Tabacum.*

Peronospora minima sp. nov.[17]

Hypophyllous, forming an irregularly distributed grayish growth over the entire under surface of the leaf, epiphyllous discoloration apparently merely chlorotic; conidiophores straight or slightly flexuose, 2–10 from a stoma, short and little branched, $150–300 \times 8–10\ \mu$, branching 1–3 or 4 times, the branches straight, ultimate branchlets at acute angles, axial scarcely deflected, sometimes ultimate branchlets arise in groups of three, conic, $15–20 \times 4–6\ \mu$, occasionally the conidiophore is reduced and bears only 3 or 4 conidia-bearing branchlets; conidia globose, very light yellowish-brown, 28–32 μ; oöspores subglobose, 65–80 μ, epispore yellowish, wrinkled rather conspicuously; oögonium rather thick walled, slightly larger than the oöspore, somewhat flattened.

Type, in herbarium Wilson, collected by G. Lagerheim at Tromsö, Norway, on *Saxifraga cernua* L., Aug. 1895.

This is the smallest species of the genus and stands out sharply not only from the other species on Saxifragaceae all of which are considerably larger and better developed, but from the species which it appears to approach closest as well. In size and method of branching of the conidiophores it approaches nearest to *P. violacea* Berk., while the globose conidia might suggest a relationship to some of the larger species such as *P. Phyteumatis* Fuckel.

[17] Hypophyllis, conidiophoris densis caespitosis, griseis; conidiophoris rectis vel flexuosis, 2–10-fasciculatis, brevis, pauci ramosis, $150–300 \times 8–10\ \mu$, 1–3 vel 4-ies ramosis, ramis rectis, ultimis conicis, $15–20 \times 4–6\ \mu$, vel conidiophoris minimis, cum 3–4 conidiis; conidiis globosis, diluto-aureo-bruneis, 28–32 μ; oosporis auriis, diam., 65–80 μ.

EXPLANATION OF PLATES CXXXV AND CXXXVI

Plate 135. *Peronospora Lepidii* and *P. Chamaesycis*

Figs. 1–10. *Peronospora Lepidii.* (Figs. 1–7 on *Lepidium virginicum* from Kentucky—N. Am. Fungi *1406b.*—Figs. 8–19 on *L. ruderale,* from Victoria, Australia.)

Figs. 1–5. Conidiophores of the American specimens.
Fig. 6. Two conidia from the same specimen.
Fig. 7. Group of oöspores from the same specimen.
Figs. 8, 9. Conidiophores of the Australian specimen.
Fig. 10. Two conidia from the same specimen.

Figs. 11–13. *Peronospora Chamaesycis.* (On *Chamaesyce serpens* from Kansas—Fungi Columb. *1750.*)

Fig. 11. Conidiophore.
Fig. 12. Group of conidia.
Fig. 13. Two oöspores.

Plate 136. *Peronospora* on *Saxifragaceae*

Figs. 14, 15. *Peronospora Chrysosplenii.* (On *Chrysosplenium alternifolia* from Bohemia.—Sydow Phyc. Prot. *202.*)

Fig. 14. Conidiophores.
Fig. 15. Conidia.

Figs. 16, 17. *Peronospora Saxifragae.* (On *Saxifraga granulata* from Bohemia.—Sydow Phyc. Prot. *220.*)

Fig. 16. Conidiophore.
Fig. 17. Conidia.

Figs. 18–22. *Peronospora minima.* (On *Saxifraga cernua* from Norway.)

Figs. 18–20. Conidiophores.
Fig. 21. Group of conidia.
Fig. 22. Two oöspores.

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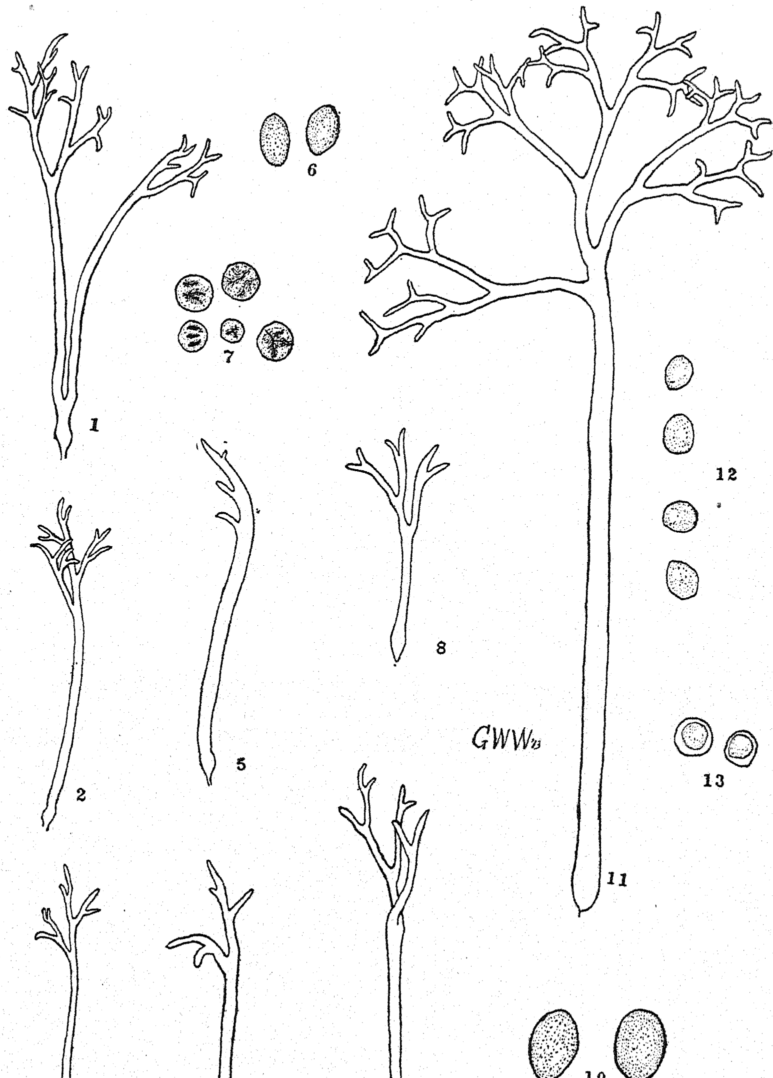
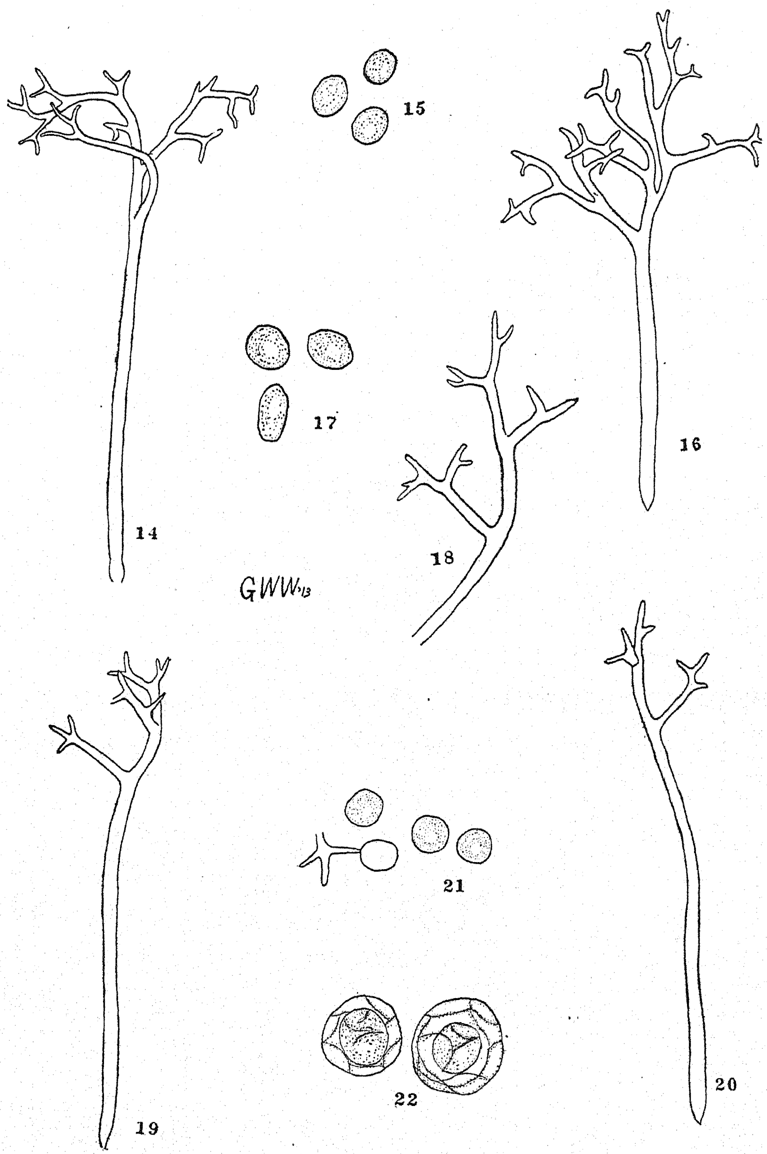
NEW BRUNSWICK, NEW JERSEY.



1–10. PERONOSPORA LEPIDII; 11–13. PERONOSPORA CHYMÆSYCIS



14, 15. PERONOSPORA CHRYSOSPLENI; 16, 17. PERONOSPORA SAXIFRAGÆ; 18–22. PERONOSPORA MINIMA

CONIDIUM PRODUCTION IN PENICILLIUM[1]

CHARLES THOM

Certain morphological features are common to the species which for convenience are lumped together under the generic name, *Penicillium*.

CONIDIOPHORES

The fertile hyphae or conidiophores may arise as branches from submerged or from aerial hyphae. They are septate except when they are very short. They have approximately the same diameter as the vegetative hyphae from which they branch. They are uniform in diameter from point of origin to the point where the conidium-producing complex of cells begins to form. The apex of the uppermost cell is frequently though not always swollen somewhat like the vesicle of *Aspergillus,* and the distal ends of branches if such are present are commonly also swollen, but the appearance of such swelling is not a uniform character within the species. The conidiophore proper should be measured from the point of origin to the base of the fruiting group of cells or branches. This part ceases to grow in length when fruiting commences, hence this measurement is more characteristic than a measurement including fruiting mass which frequently increases in length for several weeks by the production of new conidia.

CONIDIAL APPARATUS[2]

The essential organ of conidium production in this group is the fertile cell which has been differently named by various workers as a basidium by Brefeld, Stoll, the writer in part, as sterigma, by Westling, Bainier, Wehmer, and others. The term "conidiiferous cell" was used in the English descriptions of writer's previous paper because the word had no morphological significance in

1 Published by permission of the Secretary of Agriculture.

2 This section of the paper was presented to the Botanical Society of America at Washington, D. C., December 27, 1911, under the title "The Connective between Conidia of *Penicillium,*" with an abstract appearing in Science, N. S., vol. 35, no. 891, January 26, 1912, pp. 149–150.

other groups. The use of these terms has been fully discussed by Westling[3] who prefers the term sterigma. These fertile cells are uninucleate, tubular rather than flaskshaped. While not uniform in diameter such swelling as is found is usually about the middle of the length. The variations in shape are such as may be easily attributed to the effect of crowding many such cells into compact verticils upon the dome-like apex of the fertile branch. The diameter of the cell is usually a little less than that of the branch below it. The tubular form with an average diameter is maintained to a length varying somewhat but fairly characteristic for each species. There is, then, a more or less abrupt reduction to a smaller tube (figure a), from which the conidia arise. This tube may be found to vary within the field of the microscope from imperceptible to several microns in length.

CONIDIUM FORMATION

The process of conidium formation as far as it has been followed cytologically, involves the division of the cell nucleus, the migration of one of the daughter nuclei to the tip of the tube which grows rapidly in length, the formation of a cross-wall in the tube at a distance from the tip characteristic for the species, and the swelling of the new conidium to the size and shape typical for the species. Some preparations give no hint of this process. If conidium formation be for some reason arrested, the newest conidium may rest directly upon the basal cell without a vestige of a tube between. In other cases, a tube several microns long may separate the conidium from the main body of the parent cell. Every gradation may be found in the same culture if it is watched over a period of several days to several weeks. No species has shown conidia globose from the first. Such appearances may be easily found but examination of fresher or younger colonies shows them to be misleading. However quickly the stage may pass, the conidium of Penicillium arises as a cylindrical or barrel-shaped segment cut by cross-wall from the end of the fertile tube of the conidiiferous cell. This tube was designated by the writer in a previous paper as the sterigma because of its really permanent character as a conidium-forming organ of the cell. One might reasonably designate it a character of the genus.

[3] Westling, R., Arkiv. f. Bot. Bd. II (1911), no. 1, pp. 1–156.

CONNECTIVE

Once formed, the conidium reaches characteristic form and size by swelling and laying down new walls for itself within the primary wall which is continuous with that of the parent cell. The appearance of a connective (bridge, or disjunctor) is due to this old wall. The presence of this connective is figured by various authors and noted as common, but without explanation by Westling. The appearance arises in certain species[4] and especially in particular media from the swelling and rounding up of the new cell within the old wall. Such formation is more frequent in

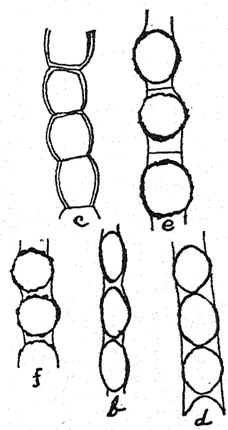


FIG. 1. Conidium formation and the connective in *Penicillium*: *a*, conidium-bearing cell showing the tube and a conidium in its elliptical stage; *b, d, f*, chains of conidia showing different appearances of the connective but no cross-walls; *c, e*, chains of conidia in which the original cross-wall shows.

media poor in nutrients especially in carbohydrates. In such cases the new wall following the plasma membrane, splits away from the old at the ends of the cell leaving an apparently empty space bridged across by the lines made by the primary wall. In especially favorable cases the original cross wall can be traced. Commonly the cells remain in contact with the center of the cross-wall where doubtless protoplasmic connections from cell to cell are continued for some time. In many cases, interpretation of the appearance would be impossible unless the true arrangement of walls had been traced out in these favorable forms.

[4] These statements are equally true for all species of Aspergillus examined by the writer.

In preparations which show no connective the explanation is equally simple, the primary wall adheres to the new or secondary wall, and takes the shape of the new cell. In some species conidia are delicately granular, rough, or spinulose in particular rows or cultures and not in others. There is some reason to think that these cases of conidia occasionally granular are due to the presence of this old wall which takes that form under such conditions and not under others. It has not been possible to define these conditions or prove the suggestion thus far.

Shape and Measurements of Conidia

Much weight has been frequently given to shape and measurement of conidia. Westling has based his key to species upon data of this kind. Examination of his descriptions shows that he has seen the great variation of both factors even in cultures upon prune-gelatine. When successive cultures upon media of decidedly different composition are compared the contrasts become greater still. Even upon a single medium the difficulty of determining which of the sizes and shapes shall be taken as typical is noted by Westling himself, and fully appreciated by the writer with Westling's own cultures and his paper in hand for verification upon prune-gelatine. As noted by Westling in his descriptions of species certain forms give very uniform data while others are variable. Among these variable forms, the conidia may be nearly all definitely elliptical in one culture and predominantly globose upon the next culture in another substratum but grown from these elliptical spores.

Metulae

Westling has measured and described carefully the branches bearing the conidiiferous cells or sterigmata. To these he gives the new name metulae. In certain species the new term is found significant and useful. In others, attempts to place value upon the study of these branches as metulae have proved difficult. A considerable number of the forms studied show present in this position branches of very unequal length. Occasionally the same verticil would contain sterigmata, metulae and a main central branch bearing another verticil of metulae above; the metulae would thus be

formed in primary, secondary or tertiary branching groups or verticils in the same fruit mass. In other species it would be necessary to record metulae as absent so that the conidia-bearing verticils would be produced directly upon the apices of the conidiophore and its branches. This latter conception can be readily applied in a few species. Descriptions and figuring of branching systems as typical for species involves many difficulties as is recently noted by Wehmer.[5] In the same culture, corresponding septa of different conidial masses may show, single, opposite, or verticillate branching, with a change of nutrient the variation may be carried in one direction or another. Literal following of the keys furnished for generic discrimination might place different fruits of the same colony in several genera.

UNITED STATES DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

5 Wehmer, C. Mycologisches Centralblatt, Bd. II (1913), heft 4, p. 197.

NEWS AND NOTES

Dr. Mel T. Cook delivered an illustrated lecture at the New York Botanical Garden, June 13, on diseases of potatoes.

Professor H. C. Beardslee, of Asheville, North Carolina, visited the Garden July 1 on his way to Lake Placid in the Adirondacks.

Professor L. H. Pennington spent several days at the Garden early in July, continuing his work upon the genus *Marasmius* for North American Flora.

Professor T. H. Macbride, for many years professor of botany in the State University of Iowa and for some time past acting president, has recently been appointed president of the university.

Mr. W. H. Long, forest pathologist for the United States Department of Agriculture, recently spent several days at the New York Botanical Garden, studying certain fungi of forest trees collected in Florida and North Carolina.

Dr. Fred J. Seaver spent the early part of July at Portland, Connecticut, where he was engaged in the collection and study of local fungi, especially the fleshy Discomycetes.

Miss Florence McCormick, assistant professor of agricultural botany in the Agricultural Experiment Station of Nebraska, is spending part of the summer at the New York Botanical Garden, engaged in a study of the cytology of the Mucorales.

The American Journal of Botany for March contains the address of the retiring president of the Botanical Society of America on Problems and Progress of Plant Pathology. The same number also contains an article by Alban Stewart on Some Observations on the Anatomy and Other Features of the Black Knot; also an article by Professor R. A. Harper on Cleavage in *Didymium melanospermum* (Pers.) Macbr. The entire number shows a mycological trend. The April number contains a lengthy article by Bascombe Britt Higgins on Contribution to the Life History and Physiology of *Cylindrosporium* on Stone Fruits.

The Botanical Gazette for April contains a note by Dr. Roland Thaxter on the ascosporic condition of the genus *Aschersonia* Montagne. It had been suspected that the ascosporic form, if such existed, would place this genus among the Hypocreaceae, possibly with the genus *Hypocrella*. After careful search for the ascosporic form of *Aschersonia* in the island of Grenada, the search was finally rewarded by finding a few which showed suspicious looking pustules which proved to be perithecia. In Trinidad, species of *Aschersonia* were more numerous and often showed the ascosporic stage. A study of these plants shows *Aschersonia* to be closely related to the genus *Cordyceps*. The article contains a description and illustration of the perfect stage of *Aschersonia turbinata* Berk.

ORIGIN OF THE VOLVA APERTURE IN CRYPTOPORUS VOLVATUS (PECK) HUBBARD

This interesting species of the Polyporaceae is quite common on fire-killed specimens of *Pinus rigida* west of Albany. It is one of the earliest species of that family to mature. Mature specimens were found at intervals between May 10 and June 1. The young specimens are nearly globose and sometimes slightly varnished upon the upper surface, so that at first glance they might easily be taken for the button stage of *Fomes ungulatus*. A cross section of this stage, however, shows that the hymenium is nearly if not quite mature and the absence of any opening in the thick,

hard volva naturally gives rise to the question of how that aperture which is seen in mature specimens originates.

About the time the spores are mature, a round hole is bored in the crust-like volva by small weevils (*Plesiocis* sp.), which invade the interior cavity of the fungus in great numbers and seemingly feed upon the spores. At least, they become covered with them and also invade the borings through the bark of the pines made by emerging adult bark-beetles (*Tomicus*), through which the sporophores of the fungus usually emerge. The weevil is hence an important agent in the dissemination of the spores and is responsible for the round apertures in the volva of mature specimens of *Cryptoporus*.

Another beetle, one of the short-winged scavenger beetles (*Placusa despecta* Er.) frequently takes refuge within the volva after the initial opening has been made by the weevil and may also be instrumental in the dissemination of the spores.

I am indebted to Mr. D. B. Young of the New York State Museum for the insect determinations.

H. D. HOUSE.

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COLLYBIA RADICATA (RELH.) QUÉL.

MYCOLOGIA

VOL. VI SEPTEMBER, 1914 No. 5

ILLUSTRATIONS OF FUNGI—XIX

WILLIAM A. MURRILL

The accompanying illustrations,[1] including the two halftone plates, were all made from specimens collected in and near New York City. Four of the species described are known to be edible, one of them, *Agaricus arvensis,* being an important edible species in many parts of Europe.

Collybia radicata (Relh.) Quél.

ROOTING COLLYBIA

Plate 137. Figure 1. × 1

Plate 138. Slightly reduced

Pileus fleshy, thin, convex to nearly plane, 3–7 cm. broad; surface smooth, viscid when moist, often radiate-rugose, grayish, grayish-brown, or umbrinous, the center usually darker; context white; lamellae white, broad, rather distant, adnexed; spores ellipsoid, hyaline, with a slight oblique apiculus at one end, 15–17 × 10–12 μ; stipe long, with a very long root, slender, firm, generally slightly tapering upward, stuffed, white above, concolorous or slightly paler below, 10–20 cm. long, 4–8 mm. thick.

This common and widely distributed edible species may be looked for in open deciduous woods. In the vicinity of New York City, the typical form figured occurs most frequently about beech stumps and under beech trees, and the long rooting base of the

[1] The colored plate to accompany this article was being made in England and has not yet come to hand. It will be distributed with the next number of MYCOLOGIA.

[MYCOLOGIA for July, 1914 (6: 161–220), was issued July 14, 1914.]

stipe can usually be traced to a dead root, from which the plant derives its chief supply of nourishment.

Agaricus arvensis Schaeff.

HORSE MUSHROOM. FIELD MUSHROOM

Plate 137. Figure 2. × 1

Pileus large, convex, 6–15 cm. broad; surface white, becoming yellowish with age or on drying; context white, thick, highly flavored and easily digested; lamellae white to pale-pinkish at first, at length brown; spores ellipsoid, smooth, brown, 9–11 × 6 μ; stipe long, white, often enlarged at the base, 5–10 cm. long, 8–16 mm. thick; annulus of two parts, membranous and white above, radiately split and tinged with yellow below.

This species grows in rich soil in pastures, fields, and wood borders from midsummer to early fall. It resembles the common mushroom, but is larger, with longer stipe, paler lamellae, and a peculiar double annulus. I have often eaten it in Sweden and found it delicious. The slender, wood-loving *Agaricus silvicola* can hardly be distinguished from it at times.

Agaricus silvicola Vitt.

FOREST MUSHROOM

Plate 139. × ½

Pileus convex or expanded, 5–12 cm. broad, all parts of the plant except the lamellae being white at first and becoming tinged with straw-color in places with age or almost entirely on drying; surface smooth, glabrous or slightly silky; context white; lamellae thin, close, rounded behind, free, pale-reddish-gray when young, becoming darker with age, and finally brown or blackish-brown with a chestnut tint; spores ellipsoid, brown, 7.5 × 4 μ; stipe long, equal, smooth, stuffed or hollow, bulbous, white, 10–20 cm. long and 6–10 mm. thick; veil usually single, forming a thin, membranous annulus decorated with floccose patches below.

This beautiful edible species is of wide distribution, but unfortunately not very abundant. It occurs in open woods and wood borders, in rich soil or vegetable mold. Its smaller size and more simple veil distinguish it from *A. arvensis*.

AGARICUS SILVICOLA VITT.

Lepiota brunnescens Peck

BROWNING LEPIOTA

Plate 137. Figure 4. × 1

Pileus thin, convex or nearly plane, usually obtuse or umbonate, 2–8 cm. broad; the entire plant changing to brown when bruised or after 12–24 hours of drying; surface whitish, the cuticle soon cracking and forming chestnut-colored squamules except in the center, margin often rosy, radiate-rimose at times; context white, taste sweet; lamellae free, at first white, crowded, ventricose; spores ovoid, appendiculate, smooth, hyaline, yellowish in mass, $6–8 \times 4–5\,\mu$; stipe equal or slightly enlarged below, white, changing at first to reddish-brown and then to brown below the annulus on drying, fibrous to glabrous, hollow, 3–7 cm. long, 2–7 mm. thick; annulus median, fixed, usually ample and persistent.

This species occurs rather rarely in open woods and grassy places from New York and New Jersey through Ohio and Missouri to southern California. Few collectors know it on sight, but it should be recognized by the brown color which the entire sporophore assumes after about a day of drying. The flesh is white, sweet, and probably edible, but it has not been tested so far as known. The species might be confused by the beginner with small plants of *Lepiota americana.*

Laccaria ochropurpurea (Berk.) Peck

YELLOWISH-PURPLE LACCARIA

Plate 137. Figure 5. × 1

Pileus fleshy, firm, subhemispheric or convex becoming plane or slightly centrally depressed, often very irregular and very variable in size and shape, solitary or rarely gregarious, 5–10 cm. broad; surface hygrophanous, purplish-brown when moist, grayish or pale-alutaceous when dry, unpolished, margin decurved; context edible; lamellae thick, distant, broad, adnate or decurrent, purplish; spores globose, verruculose, $8–10\,\mu$; stipe variable, short or long, equal or sometimes thicker in the middle, sometimes at each end, fibrous, solid, concolorous or paler, firm, 3–8 cm. long, 4–12 mm. thick.

This species is known throughout temperate North America, occurring in open grassy or bushy places in thin woods, often associated with its smaller relative, *Laccaria laccata,* of which it

has at times been considered only a larger form. It is edible, but of only tolerable flavor.

Inocybe geophylla (Sow.) Quél.

COMMON WHITE INOCYBE

Plate 137. Figure 6. × 1

Pileus fleshy, thin, conic or ovoid becoming expanded, conically umbonate, 1.5–2.5 cm. broad; surface silky-fibrillose, smooth, commonly white or whitish, rarely lilac; lamellae crowded, rather broad, ventricose, adnexed, white becoming clay-colored; spores ellipsoid, smooth, ochraceous, $8–10 \times 4–6\,\mu$; cystidia cylindric-fusoid, $40–60 \times 12–20\,\mu$; stipe equal, firm, stuffed, white, mealy at the apex, 2.5–6 cm. long, 2–4 mm. thick.

This species is common on heavy, wet soil on the shaded banks of streams or in low open woods throughout temperate regions. It is so different from most species of *Inocybe* that the beginner is usually puzzled in identifying it. A beautiful pale-lilac variety sometimes occurs, which Boudier has figured in his plate 125. I have found this variety quite abundant in the state of Washington.

Scleroderma verrucosum (Bull.) Pers.

SMALL-WARTED SCLERODERMA

Plate 137. Figure 7. × 1

This rather uncommon species was described and figured in MYCOLOGIA for January, 1910. The illustration on the plate accompanying the present article is made from younger material, and the plants have more purple in them than those represented on the former plate.

Tremella lutescens Pers.

COMMON YELLOW TREMELLA

Plate 137. Figure 8. × 1

Very soft and watery, undulate-gyrose, with entire, naked lobes, the clusters sessile, whitish to pale-yellowish, and finally luteous, 1–5 cm. broad, leaving a very small residue when dried; spores globose, $12–15\,\mu$.

This species is widely distributed, occurring commonly on dead

branches of both deciduous and evergreen trees in woods or moist places. The genus *Tremella* contains fungi that are gelatinous, tremulous, immarginate, not papillate, with basidia that become four-parted, each part bearing a single spore. The species must be collected during wet weather, otherwise they will not be seen. After drying, they may be soaked in water to restore them to their original form. Members of closely related genera, such as *Exidia, Dacryomyces,* and *Hirneola,* are liable to be confused with species of *Tremella* by the beginner.

Mycena succosa Peck

JUICY MYCENA

Plate 137. Figure 9. × 1

Pileus firm, between cartilaginous and fleshy, campanulate or convex, cespitose, 2–4 cm. broad; surface minutely tomentose, cinereous or very pale reddish-gray, darker at the center, the margin exceeding the lamellae and incurved; context abounding in a thin watery or serum-like juice, changing to purplish and black when cut; lamellae slightly ascending, thin, close, emarginate with a slight decurrent tooth, tapering toward the outer extremity, whitish with a pale-reddish-gray tint; spores subglobose, minute, 4μ; stipe firm, equal or slightly tapering upward, often curved, minutely tomentose, containing a whitish pith, pale-reddish-gray at the apex, dark-reddish-gray below, 4–8 cm. long, 2–3 mm. thick.

This extremely interesting little species occurs in woods on fallen decayed trunks of deciduous trees. When wounded, it exudes a serum-like fluid which blackens on exposure to the air. The sporophore therefore soon becomes spotted with black when handled and usually turns black on drying, as in the Indian Pipe. *Mycena haematopa* is a related species which exudes a dull-reddish juice when wounded.

NEW YORK BOTANICAL GARDEN.

A NEW GYMNOSPORANGIAL CONNECTION

F. D. Fromme

The genus *Gymnosporangium*, according to Kern,[1] is represented in North America by some 32 species. Of these, all but one are heteroecious, the aecial stages being found on members of the Hydrangeaceae, Rosaceae, and Malaceae families, while the telial stages are restricted to the family Juniperaceae. The single autoecious species, *Gymnosporangium bermudianum*, bears all its spore forms on species of *Juniperus*. Because of this limited selection of hosts, as well as their unique morphological characters, the members of this genus have been classed among the most restricted and isolated of the rusts. Until recently, no aecial stages were known on other than pomaceous hosts and it had been assumed that they were restricted to the family Malaceae. The first exeception to this rule was established by Arthur[2] in 1908 when *Gymnosporangium exterum* on *Juniperus virginiana* was successfully cultured on *Porteranthus stipulatus*, thus adding the family Rosaceae to the list of aecial hosts. The further addition of the family Hydrangeaceae was made by Arthur[3] in 1911 when *Gymnosporangium gracilens* was shown to have its aecial stage on *Philadelphus* and related genera. These three families are evidently closely related and are all included under the order Rosales.

As a result of a series of observations, followed by successful inoculation tests, the writer is now able to extend the list to include a fourth family, the Myricaceae, and to establish the identity of *Aecidium myricatum* Schw. and *Gymnosporangium Ellisii* (Berk.) Farl. This work is a part of the series of "Cultures of Uredineae" that have been in progress at the Purdue Experiment Station under the direction of Dr. J. C. Arthur since 1899, and is published by permission in advance of the 1914 report.

The establishment of the connection between *Aec. myricatum*

[1] N. Am. Flora 7: 188–211. 1912.

[2] Mycologia 1: 253–254. 1908.

[3] Mycologia 4: 63. 1911.

and *Gym. Ellisii* not only carries the aecial hosts of the genus to a group outside of the Rosales but to one that is apparently widely separated from them in phylogeny, the Myricales being the fourth order of Dicotyledoneae in Engler and Prantl's Natürliche Pflanzenfamilien, while the Rosales is the eighteenth. This is not in itself so surprising, as similar wide ranges of hosts are known in other rust genera. It shows, however, that the species of *Gymnosporangium* are a much less restricted group than was formerly supposed, and suggests the possibility that the aecial hosts of other unconnected species may also be found in groups other than Rosales.

The aecium of *Aec. myricatum* is of the cupulate type, a type which has only recently been recognized as occurring in the genus *Gymnosporangium* and is at present known in but two species, *G. Blasdaleanum* and *G. Sorbi*, in addition to the one under discussion. The remaining species of *Gymnosporangium* have aecia of the cornute type, which had for a long time been considered exclusively diagnostic of the genus. *G. Ellisii* in addition to its cupulate aecia has the hamaspora or phragmidium type of teliospores, in which the teliospore has commonly more than two cells, the variation being from two to five. *G. Blasdaleanum* also has cupulate aecia and teliospores of the hamaspora type, but *G. Botryapites* has teliospores much like those of the two foregoing species and cornute aecia. The telial stage of *G. Sorbi*, of which the aecia are cupulate, is unknown.

The suggestions that have led to the establishment of this connection were obtained from a morphological study of the aecium supplemented by field observations on the association of hosts. A quantity of the aecium on *Myrica carolinensis* was collected at Woods Hole, Mass., in 1912, by the writer, for a morphological study. The evident germ pores of the aeciospores and other features suggested that it might possibly be the aecium of a *Gymnosporangium*. In May of the following year, 1913, Dr. R. A. Harper, Dr. B. O. Dodge, and the writer made a trip to the pine barrens at Lakehurst, N. J. Both *Gym. Ellisii* and *Gym. Botryapites* were found there in abundance on the southern white cedar, *Chamaecyparis thyoides*, and three possible alternate hosts, *Amelanchier canadensis, Aronia arbutifolia,* and *Myrica carolinensis*

were found in the vicinity. After a search, old aecia were found on Myrica leaves of the preceding year. Material of both species of *Gymnosporangium* was taken to New York City. *Gym. Ellisii* was sown there on *Aronia arbutifolia, A. nigra,* and several species of *Crataegus* without result. No *Myrica* plants were available for use. *Gym. Botryapites* was sown on *Amelanchier canadensis* and *A. Asiatica* and produced pycnia and aecia on both. The Lakehurst region was again visited in August of the same year and aecia were found on *Amelanchier, Aronia,* and *Myrica.* The aecium on *Amelanchier* proved to be that of *Gym. Botryapites,* the one on *Aronia* was *Roestelia transformans,* and that on *Myrica, Aecidium myricatum.* Since *Gym. Ellisii* had failed to infect *Aronia* in the trials made at New York, it seemed probable that *Myrcia* would prove to be its alternate host. This solution would still leave *Roestelia transformans* without a telial connection and another *Gymnosporangium* should be present in the vicinity.

A third trip to Lakehurst was made this spring, May 1914, and a quantity of *Gym. Ellisii* was obtained and sent to the Purdue Experiment Station for culture work. The germinating teliospores were sown, May 6, on *Aronia arbutifolia, Amelanchier canadensis,* and *Myrica cerifera.* The sowings were made by Mr. C. A. Ludwig, who was in charge of the rust cultures at that time. Although the leaves of the Myrica were quite small at the time of inoculation, a vigorous infection resulted, and an abundance of pycnia were produced on May 18, and aecia on June 6. No infection was produced on either of the other trial hosts.

The distribution of *Aec. myricatum* conforms with that of *Gym. Ellisii* in that both are found along the Atlantic coast from Massachusetts to Delaware. The latter, however, is also known from northern Florida and southern Alabama, while *Aec. myricatum,* so far as I can ascertain, has not been collected at any point south of Delaware.

Aecidium myricatum was named and briefly described by Schweinitz, in 1832, from a specimen on *Myrica cerifera* sent him from New York by Dr. Torrey. This description has been amplified somewhat by DeToni in Saccardo's Sylloge Fungorum but is

still incomplete. I am therefore appending a description of the pycnia and aecia with the complete synonomy of the combined species and its distribution. The first name applied to the telial stage was *Podisoma Ellisii* Berk., in 1874; which was, however, antedated by the Schweinitzian name.

Gymnosporangium myricatum (Schw.) comb. nov.

Caeoma (Aecidium) myricatum Schw. Trans. Am. Phil. Soc. II. 4: 294. 1832.

Aecidium myricatum Schw. Trans. Am. Phil. Soc. II. 4: 309. 1832.

Podisoma Ellisii Berk. Grevillea **3**: 56. 1874.

Hamaspora Ellisii Körn. Hedwigia **16**: 23. 1877.

Gymnosporangium Ellisii Earl.; Ellis, N. Am. Fungi *271*. 1879.

Phragmidium Ellisii DeToni, in Sacc. Syll. Fung. **7**: 750. 1888.

Tremella Ellisii Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

O. Pycnia epiphyllous, gregarious, in crowded circular groups. 2–5 mm. in diameter, on blackened areas, subepidermal, orange-yellow, globose in vertical section, 140–190 μ broad by 175 μ deep; ostiolar filaments 30–80 μ long.

I. Aecia hypophyllous, fructicolous and caulicolous, in crowded groups, on discolored hypertrophied areas, cupulate, 0.2–0.3 mm. in diameter; peridium yellowish, fragile, becoming lacerate to the base, slightly recurved; peridial cells oblong, 26–29 by 32–39 μ, overlapping, the outer wall thick, 7–10 μ, smooth, transversely striate, the inner wall much thinner, 2–3 μ, closely and prominently verrucose; aeciospores globoid to oblong, 24–30 by 27–34 μ, the wall pale-yellow or colorless, 2–3 μ thick, closely and strongly verrucose, the pores 6–8, scattered.

ON MYRICACEAE:

Myrica carolinensis Mill., Connecticut, Massachusetts, New Jersey.

Myrica cerifera L., Delaware, New Jersey, New York.

III. Telia. (For description see N. Am. Flora 7: 203. 1912.)

ON JUNIPERACEAE:

Chamaecyparis thyoides (L.) B.S.B., Alabama, Delaware, Florida, Massachusetts, New Jersey.

TYPE LOCALITY: New York, on *Myrica cerifera*.

DISTRIBUTION: Along the Atlantic coast from Massachusetts to Delaware, and in northern Florida and southern Alabama.

EXSICCATI: Ellis N. Am. Fungi *230, 271*; Ellis & Ev. Fungi Columb. *55, 62*; Thüm. Myc. Univ. *1224, 1936*; Seym. & Earle, Econ. Fungi *246*; Roum. Fungi Sel. *4921*; Rab.-Wint. Fungi Eur. *2920;* Barth. Fungi Columb. *4001*.

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TYPE STUDIES IN THE HYDNACEAE[1]—VII. THE GENERA ASTERODON AND HYDNOCHAETE

Howard J. Banker

The genus *Asterodon* is monotypic, having been established by Patouillard in 1894 on *A. ferruginosum* Pat.[2] The genus may be characterized as follows:

Hymenophore epixylous, perennial, wholly resupinate, separable, umber to fulvous; substance dry, fibrous, concolorous; hymenium setulose with reddish straight, simple or branched setae; teeth slender, terete, tapering; spores hyaline, smooth; hyphae slender, somewhat rigid, non-septate.

The presence and character of the setae is one of the distinguishing features of the genus. They are modified free ends of single hyphae which may project as simple spines or may branch at right angles into three or four spines giving a stellate appearance. The end of the hypha in either case has the walls thickened and becomes darker, more reddish in color and tapers to a sharp point. These should by no means be called cystidia as they are distinctly spine-like and not at all of the form of sacs or cysts. It is to be observed that the term cystidium has come to be used very loosely and inaccurately in some late mycological literature and is frequently employed where the term seta should be used.

In 1897, Charles H. Peck founded his genus *Hydnochaete* on *H. setigera* Peck[3] a single species which proves to be identical with *Asterodon ferruginosum* Pat. *Hydnochaete* Peck is, therefore, a typonym of *Asterodon* Pat. The name *Hydnochaete,* however, had been previously used by Bresadola. Aware of this fact and not knowing the relation of Peck's genus to *Asterodon* Pat., Saccardo in 1898 proposed the name *Hydnochaetella*[4] for Peck's

[1] Investigation prosecuted with the aid of a grant from the Esther Herrman Research Fund of the New York Academy of Science.

[2] Pat. Bull. Soc. Myc. 10: 130. *Pl.* 5. 1894.

[3] Peck, Ann. Rep. N. Y. State Mus. 50: 113. 1897.

[4] Sacc. Tab. Com. Gen. Fung. 11. 1898.

genus and published the combination *Hydnochaetella setigera* (Peck) Sacc., making *Hydnochaetella* Sacc. another typonym of *Asterodon* Pat.

In 1896, Bresadola published the genus *Hydnochaete* as a monotypic genus based on *H. badia* Bres.,[5] a species from Brazil, thus antedating Peck in the use of the name. As *Hydnochaete* Bres. is also characterized by the presence of reddish setae, some confusion has arisen in respect to these genera. Bresadola expressly states that his genus *Hydnochaete* is near but distinct from *Asterodon* Pat. He also remarks that he has three forms of the species *H. badia,* the first "perfecte hydnoidea"; the second "raduloidea"; and the third "irpicoidea." Having received from Bresadola by his generous kindness authentic material of his *H. badia,* presumably a part of the original collection, we have had the opportunity of examining the characters of this interesting species.

In respect to substance, development of the hymenophore, and the character of the setae, the species appears to be distinctly congeneric with *Hydnoporia fuscescens* (Schw.) Murrill. It may also be noted that the latter species is quite variable in the development of the hymenial surface and may often be described as hydnoid, or raduloid, or irpicoid, or even polyporoid. Considering the highly variable character of both these species, the question may be raised as to whether they are specifically distinct. We are familiar with the Schweinitzian species, which is abundant in North America, and, while the Bresadolan material is not in sufficient quantity to settle the matter beyond all doubt, we believe they are distinct. *Hydnochaete badia* Bres. has a thicker subiculum and is darker colored, being umbrinous to badious within and gray-brown or fuscous on the hymenial surface, while *Hydnoporia fuscescens* (Schw.) Murrill is more fulvous both within and without.

It may be noted that the setae in *Hydnochaete* Bres. are essentially different from those in *Asterodon* Pat. In the former, there are no branched or stellate forms and the seta is not simply the modified pointed tip of a single hypha. On the contrary, they are much larger than the hyphae and appear to be a distinct morphological structure, but how they originate or what their rela-

[5] Bresadola, Hedwigia 35: 287. 1896.

tion may be to the hyphae could not be definitely determined, and probably the question could only be answered by tracing out their development in special cultures.

There remains yet to be discussed the correct name of the Schweinitzian species. A plant was described by Schweinitz in 1822 under the name *Sistotrema olivaceum,*[6] which was undoubtedly a pileate form of this same species. A specimen in the Schweinitz herbarium at Philadelphia which has all the characters of this species, including the setae, is there marked "540–31 *Irpex cinnamomeus* Epic. 19. *Hydnum olivaceum* Schw. On decaying brush. Salem." In the commentary on Schwenitz's work by Berkeley and Curtis,[7] this very specimen is commented on as "540 *H. olivaceum* Schwein.!" with the remark that it belonged to *Irpex cinnamomeus.*

In the herbarium of E. Fries at Upsala, is to be found a specimen marked "*Hydn. olivaceum* L. v Schweinitz," a specimen undoubtedly received by Fries from Schweinitz. This has all the characters of the species under discussion, including the setae. This specimen also has a critical note appended to it by Bresadola, "Non differt ab Irpici cinnamomeo & fuscescente."

As to *Irpex cinnamomeus* Fries, nothing that could be regarded as a true type was found at Upsala. However, all the specimens there placed under this name were communicated by Ellis from North America through De Thümen and were clearly our American plant with the characteristic teeth and setae.

There is probably no type specimen of *Sistotrema fuscescens* Schw. in existence, but the forms we are now discussing have been more commonly known to American mycologists under the specific name *fuscescens* either as *Hydnum fuscescens* or as *Irpex fuscescens.* In the Schweinitz Herbarium, there is a specimen marked "580–7 Syn. Fung. I. cinnamomeus Epic. 19. Irpex fuscescens Schw. Beth." which is unquestionably the same species that we are now discussing.

We append the correct names of the species here discussed, with their synonymy. It needs only to be added that *Hydnochaete* Bres. should be placed in the family Polyporaceae as treated by

[6] Schw., Schr. Nat. Ges. Leipzig 1: 101. 1822.

[7] Jour. Acad. Nat. Sci. II. 3: 215–218. 1856.

Murrill in NORTH AMERICAN FLORA, although under the Friesian system it would doubtless be placed in the Hydnaceae as part of the old genus *Irpex*.

ASTERODON FERRUGINOSUM Pat. Bull. Soc. Myc. Fr. **10**: 130. *pl. 5.* 1894.

Hydnochaete setigera Peck, Ann. Rep. N. Y. State Mus. **50**: 113. 1897.
Hydnochaetella setigera Sacc. Tab. Com. Gen. Fung. 11. 1898.

HYDNOCHAETE BADIA Bres. Hedwigia **35**: 287. 1896.

HYDNOCHAETE OLIVACEUM (Schw.)

Sistotrema olivaceum Schw. Schr. Nat. Ges. Leipzig **1**: 101. 1822.
Sistotrema fuscescens Schw. Schr. Nat. Ges. Leipzig **1**: 102. 1822.
Hydnum olivaceum (Schw.) Fries, Elench. Fung. **1**: 134. 1828.
Irpex cinnamomeus Fries, Epicr. Myc. 524. 1838.
Hydnoporia fuscescens (Schw.) Murrill, N. Am. Flora **9**: 3. 1907.

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THE DEVELOPMENT OF THE CARPOPHORES OF CERIOMYCES ZELLERI

Sanford M. Zeller

(With Plates 140 and 141, Containing 12 Figures)

A review of the literature shows that very little, if any, critical research has been done on the development of the carpophores of the fleshy pore-bearing hymenomycetes. Among the early writers, DeBary[1] mentions some of these when he divides the carpophores of hymenomycetes into two groups; viz., angiocarpic, or those forms having a marginal veil, and gymnocarpic, those forms "of purely marginal or apical progressive growth" and thus, of course, without a marginal veil. He says that *Boletus luteus* and *B. elegans* have marginal veils, while other species of this and other genera are purely gymnocarpic. Thus, with these few exceptions, he merely assigned Boletus to the gymnocarpic type of the development without a critical study of the genus. A study of the development of a species of Boletus was undertaken because it promised to throw some light upon the types of devlopment of the pileate fungi. Material for this study was collected in the fall of 1912. *Ceriomyces Zelleri* was chosen because it is so very common about Seattle, and because its gregarious habit facilitates the collection of sporophores in the young stages.

The material for the study of this species was collected in a forest of conifers on the campus of the University of Washington. It was in this place that the type specimens[2] were collected. Therefore, the identity of the species is certain.

The young fruiting bodies were found in quantities growing from a yellow mycelium which causes a matting of the conifer needles. Sections of the rhizomorphs which lead to the carpo-

[1] *DeBary, A.:* Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria. English Edition. 289–297. 1887.

[2] *Murrill, W. A.:* Pacific Coast Polyporaceae and Boletaceae. Mycologia 4: 99–100. 1912.

phores show the structure to be a pseudoparenchyma. The hyphae are 3–4 μ in diameter and the cells average 24 μ in length. The rhizomorphs are 50–90 μ in diameter. The yellow carpophores are easily recognized on the surface of this mat of rhizomorphs, and it is almost impossible for one who once knows them to mistake them for other pileate forms. The mature as well as the large immature carpophores were collected from the same mycelium. The only other species of Boletus which is common in this vicinity and might be confused with *C. Zelleri* because of its gregarious habit is *C. communis,* but the writer has never found the latter growing in this place, although the spot is often visited by him.

The material was killed in chromo-acetic acid and stained with fuchsin, using picric acid as a destaining agent. This stain gives the best results of any tried where a concolorous stain is wanted to show differentiation in protoplasmic content. A large number of small carpophores of different sizes were collected. The size of the carpophores does not necessarily correspond with the degree of development, so it is not possible to forecast the stages of growth by the size of the plants. The smallest undifferentiated fruit bodies sectioned were about 1 mm. in diameter, while some of the larger ones were 1.5 $\times$ 3 mm. however, others in which differentiation had begun to show plainly, measured 1 $\times$ 2 mm.

The first stages show no differentiation (Fig. 1). There is no indication of a universal veil, either by differential staining or by the usual coating of loosely woven hyphae. In fact, as the later stages show, there is *no* veil, either universal or partial; the carpophores are thus entirely gymnocarpic and DeBary was correct in his inference that some of the Boleti are gymnocarpic. The young undifferentiated carpophore elongates vertically and becomes three or four times longer than broad. There is no differentiation of tissue during this elongation. The carpophore is still a homogeneous mass of hyphae, their general direction being vertical in the inner part and parallel with the surface in the peripheral portion. The first differentiation begins as a superficial, darkly-staining, annular region extending around the carpophore a short distance from its summit (Fig. 2). This area grows centripetally from the periphery and slightly upward, forming what is geometri-

cally the surface of a truncated cone. This feature is the demarcation of the pileus fundament above and the stipe fundament below. However, before this differentiation is complete, the hyphae above in the pileus fundament begin a radiate growth in the peripheral portion and the palisaded cortex of the pileus is formed. Figure 3 shows this palisade of an older pileus. The ends of the excurrent hyphae are somewhat tufted, and no doubt this feature brings about the characteristic velvety surface of the pileus. This palisade extends over the summit of the carpophore and down over all sides of the pileus fundament to the deeply staining area. The hyphae in this deeply staining portion extend vertically through it. This area resembling a truncated cone becomes a plane of cleavage, and the hyphae break apart here forming a superficial annular furrow. The cleavage takes place throughout the area simultaneously; *i. e.,* it is neither decidedly centripetal nor centrifugal. Figures 4 and 5 show different stages in the cleavage process, and figure 6 is the cleavage plane of figure 5 highly magnified. After the annular furrow is formed, the ends of the hyphae which were cut off above project downward, forming a palisade which is the primordium of the hymenium. The tips of these hyphae become blunt and form a smooth surface which is always free to the exterior after its formation. It is clear, therefore, that the hymenium is exogenous in its origin.

The superficial hyphae of the stipe keep the same general relation to the periphery which they sustained in the undifferentiated carpophore. However, the ends of the hyphae which were cut off below the annular furrow project upward, forming a palisade on the lower surface of the furrow. As the stipe elongates and the furrow broadens, this palisade is carried down to form the cortex of the upper part of the stipe. Thus, the cortex of the lower part of the stipe is composed of hyphae which extend parallel with the surface, while the portion of the cortex of the stipe near the pileus is of palisaded hyphae. Figure 7 shows this feature in the cortex of the stipe. The pileus increases in size by a centrifugal growth at the margin, the hyphae turning upward and downward at this point adding to the palisaded surface and the primordium of the hymenium, respectively. At this stage the hymenium is plane and quite horizontal.

A little later, slight anastomosing elevations of the hymenial primordium appear. These are formed by a differential downward growth of the hyphae in these regions (Fig. 8). As the hyphae forming these elevations grow downward, they turn out horizontally on both sides to form the hymenium in the pores. The hymenium stains deeply while the central part or trama takes comparatively little stain. The trama is a pseudoparenchymous tissue. After it has grown down for some distance, the trama begins to broaden by a diametrical growth of the hyphae, which also become loosely associated. For this last reason, the pores of the mature carpophores can be easily torn apart or separated from the trama of the pileus. The subhymenium appears later, made up of an interwoven mass of hyphae tightly crowded together. The number of basidia is increased by the branching of the hyphae at the clamp connections in the subhymenium. The hymenium lines the pores only. The mouths of the pores are sterile. Figures 9 and 10 show vertical and transverse sections of the pores, respectively.

To sum up the development of the carpophore of *Ceriomyces Zelleri* Murrill, there is a homogenous mass of tissue which is differentiated simultaneously into pileus and stipe by a cleavage plane which gives rise to an annular furrow. The hymenium is formed in the roof of this furrow and is exogenous in its origin. *Ceriomyces Zelleri* is gymnocarpic because there is no marginal veil.

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EXPLANATION OF PLATES CXL AND CXLI

Photomicrographs by Homer O. Blair

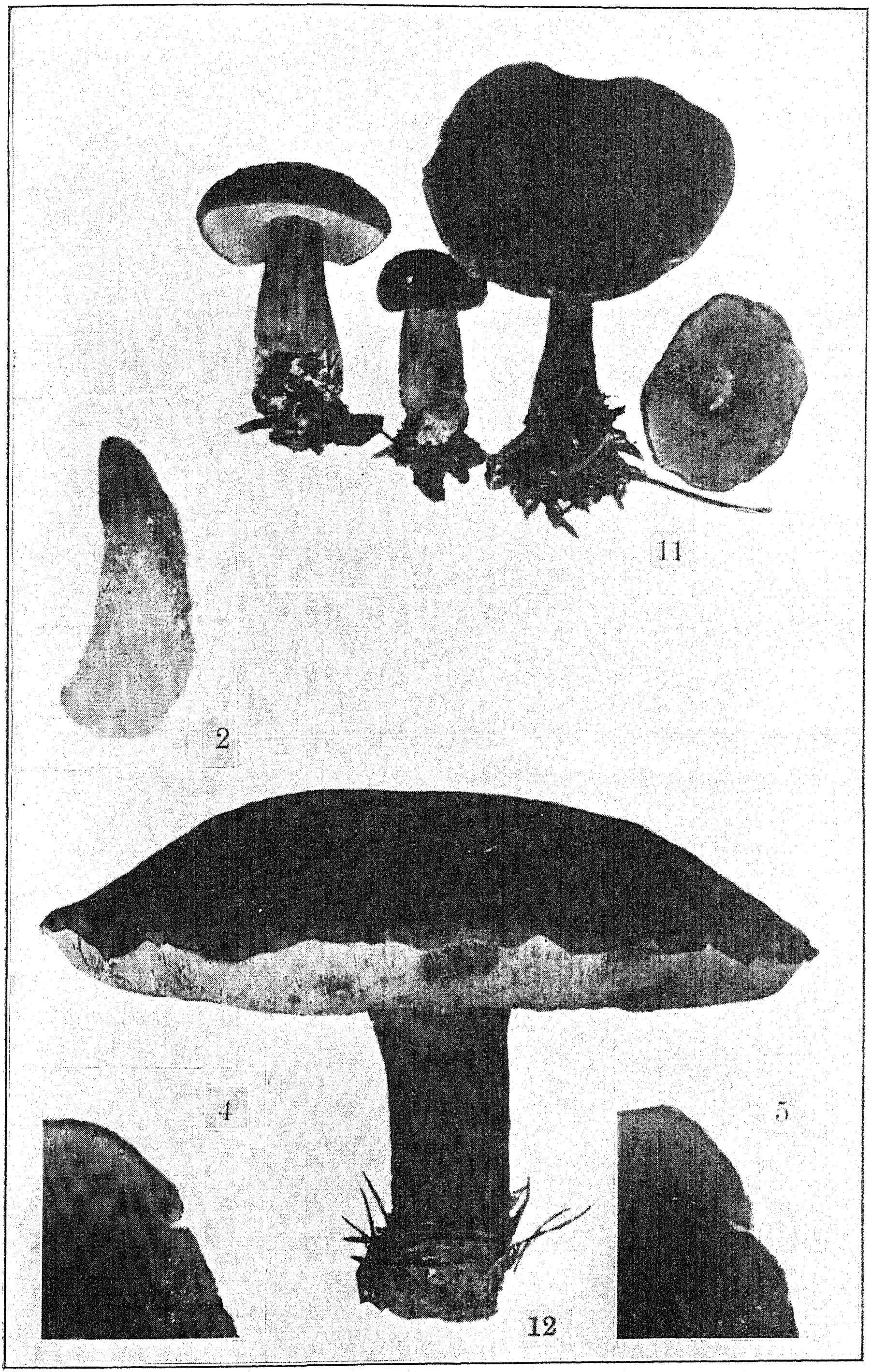
Figure 1. A small undifferentiated carpophore of *Ceriomyces Zelleri.* × 30.

Figure 2. The first differentiation in the carpophore, showing deeply staining ring in the periphery. × 20.

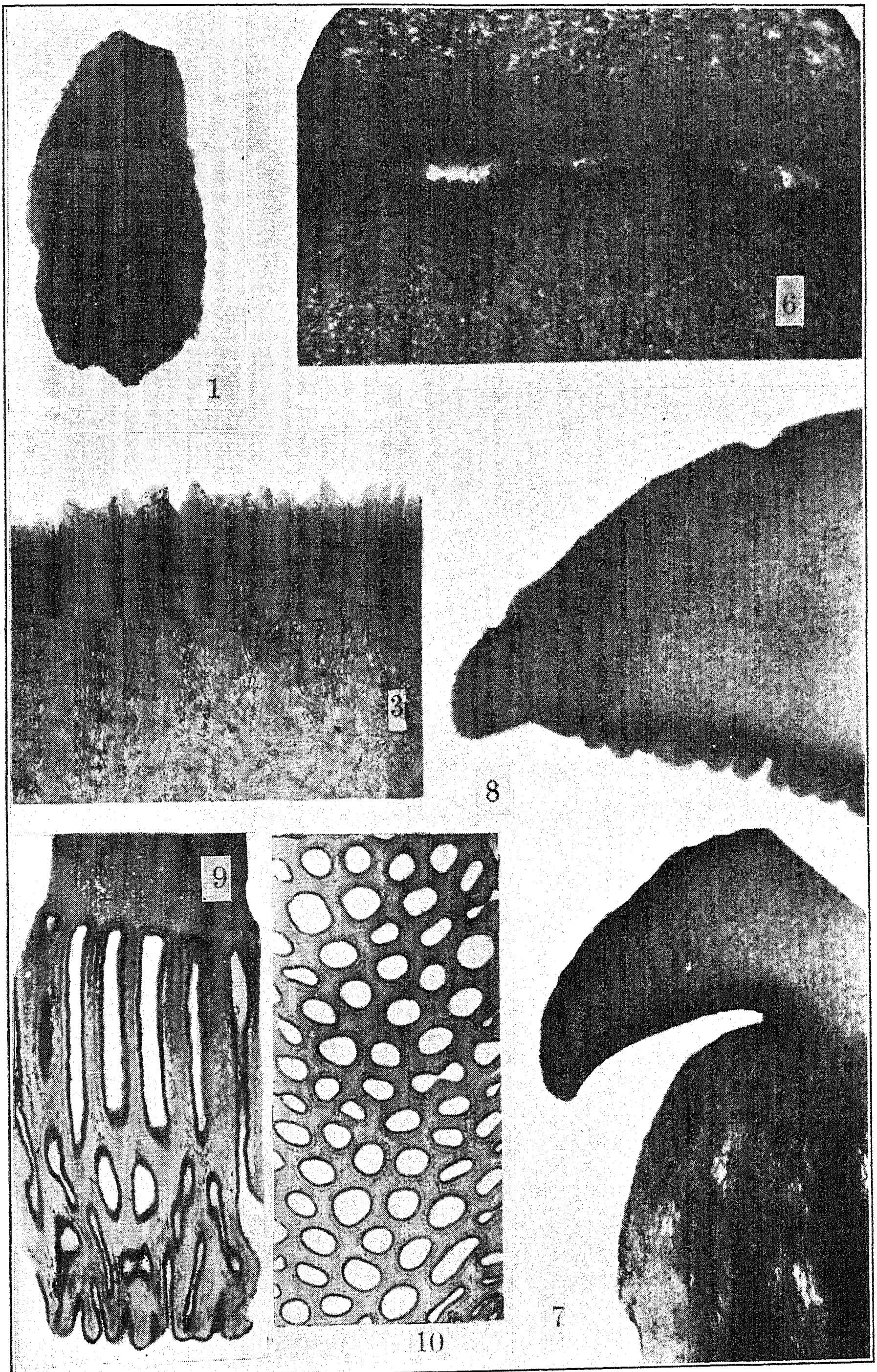
Figure 3. A portion of the palisaded cortex of an older pileus with the excurrent hyphæ tufted. × 250.

Figures 4, 5. The cleavage plane in different stages of cleavage. × 12.5.

Figure 6. A portion of the cleavage plane shown in figure 5 much enlarged. × 250.



CERIOMYCES ZELLERI MURRILL



CERIOMYCES ZELLERI MURRILL

Figure 7. A portion of a vertical section through the stipe. The junction of the palisaded cortex of the upper portion of the stipe and the portion of the cortex where the hyphæ are parallel with the surface is shown. × 25.

Figure 8. The first folding of the hymenial primordium. × 40.

Figure 9. A longitudinal section of the pores showing the trama, subhymenium, and hymenium. × 30.

Figure 10. A cross section of the pores. × 30.

Figure 11. A group of nearly mature carpophores. × 1.

Figure 12. A mature carpophore of *Ceriomyces Zelleri*. × 1.

THE SMUTS AND RUSTS OF UTAH—II[1]

A. O. Garrett

The following paper includes all of the work done since 1910, but the bulk of it embraces the results of an expedition to Grand and San Juan counties with Dr. Rydberg, of the New York Botanical Garden, during the summer of 1911. The southern part of Utah is practically a new field for the mycologist, and on this expedition several species were found not before reported from Utah. As a result, the western extension of these species was increased by several hundred miles.

The list of smuts and rusts given in the first paper was limited to those that had been collected by the writer. In the present paper are listed not only those collected by the writer and Dr. Rydberg on the southern trip, but all others referred to Utah in the available literature of the subject. Where the given species has not been collected by the writer, the name of the collector is clearly indicated in the text.

Acknowledgments for determinations of hosts and fungi are due to the same gentlemen who so kindly assisted the writer in the preparation of his first paper. Dr. Arthur has read over the manuscript, and to him the writer's thanks are especially due.

The species marked with an asterisk are not included in the list previously published.

USTILAGINALES

3. Sorosporium Saponariae Rud.

In inflorescence of *Stellaria Curtisii* (Rydb.): *2155*, July 8, 1911, La Sal Mts. near Gold Basin, San Juan Co.: alt. about 2,970 m.

[1] The first paper on "The Smuts and Rusts of Utah" was published in Mycologia 2: 265–304, November, 1910.

22. UROCYSTIS ANEMONES (Pers.) Wint.

In leaves and stems of *Trautvetteria grandis* Nutt.: *2238*, August 17, 1911, Abajo Mts., San Juan Co.; alt. about 3,394 m.

27.* USTILAGO HIERONYMI Schröt. P. Henn. Hedwigia **35**: 213. 1896.

In leaves of *Bouteloua oligostachya* (Nutt.) Torr.: *2233*, Aug. 14, 1911, Montezuma Canyon, near Monticello, San Juan Co.; alt. about 2,080 m.

28.* ENTYLOMA ARNICALE Ellis & Ev.

Bull. Torrey Club **22**: 57. 1895.

In leaves of *Aster sp.*: *830*, August 12, 1905, Big Cottonwood Canyon, near Brighton.

29.* ENTYLOMA CRASTOPHILUM Sacc. Michelia **1**: 540. 1879.

On unknown grass: *832a*, Aug. 12, 1905, Big Cottonwood Canyon.

UREDINALES

4. AECIDIUM MONOICUM Peck.

On *Arabis retrofracta* Graham: *2151*, July 7, 1911, Gold Basin, La Sal Mts., San Juan Co. Dr. Arthur has proved by cultures[2] that the form of *Aecidium monoicum* on the *Arabis* hosts is connected with *Puccinia triseti* Erik. on *Trisetum subspicatum*, and has united the two under the name of *Puccinia monoica* (Peck) Arthur. In my previous paper, I included an *Aecidium* on *Sophia* sp. as a form of *Aecidium monoicum*. This *Aecidium* differed strikingly, however, from the specimens taken on the *Arabis* hosts. The form on *Sophia* (my number *733*) had bright orange peridia that are conspicuously long; while on the *Arabis* hosts they are pale yellow and not so long. According to Dr. Arthur, the collection on *Sophia* is the aecial stage of *Puccinia subnitens* Dietel. The collection was made however at an altitude of about 2,610 meters and in a spruce-fir association, neither of which conditions point to the probable presence of *Distichlis*.

[2] MYCOLOGIA 4: 61. 1912.

7. Puccinia alternans Arthur

The above is given as the correct name of the rust reported in the writer's first list as *Aecidium* sp., No. 7. Dr. Arthur (Mycologia 1: 249. 1909) connects this with No. *1137* of the writer's collection on *Bromus Porteri* (included in No. 93 of "Smuts and Rusts of Utah" as a specimen of *Puccinia rubigo-vera*).

9. Gymnosporangium Nelsoni Arth.

On *Juniperus scopulorum* Sarg.: *2133a,* August 19, 1910, Mill D Flat, Big Cottonwood Canyon. These were old galls which had undoubtedly infected a small *Amelanchier* bush growing in the same clump with the Juniper, and bearing abundant aecia on its leaves.

The galls have also been collected on the same host by Professor C. P. Smith in Cache Co. (April 1910). Indeed, this is the commonest and most widely spread *Gymnosporangium* in Utah. Recently it has been found that the rust formerly called *Gymnosporangium durum* is the telial form of *G. Nelsoni.*

11. Melampsora Bigelowii Thüm. II.

On *Salix glaucops* Anders.: *2263,* August, 1911, San Juan Co. On *Salix monticola* Bebb?: *2187,* July 26, 1911, Monticello, San Juan Co. On *Salix pachnophora* Rydb.: *2250,* August 19, 1911, Spring Creek, Abajo Mts., San Juan Co.; 2,765 m.

15. Melamsporella elatina (Alb. & Schw.) Arth. II.

On *Cerastium scopulorum* Greene: *2249,* August 19, 1911, Abajo Mts. near West Mountain, San Juan Co., alt. about 3,030 m. On *Cerastium Behringianum* Regel: *2174,* July 15, 1911, Gold Basin, La Sal Mts., San Juan Co.; alt. about 3,272 m.

The aecial stage of this rust is *Peridermium elatinum* Schw. & Kze., of which collections in Utah are recorded by Arthur & Kern in Bulletin Torrey Botanical Club 33: 435. 1906 as follows: Collected by Marcus E. Jones, Aug. 6, 1905, Black Mountain, Manti; by Pammel & Stanton (No. 642), July 27, 1900, Brush Creek, 9,000 ft.; by Rydberg & Carleton (No. *7642*), August 5, 1905, Aquarius Plateau.

21. PHRAGMIDIUM MONTIVAGUM Arth.

On *Rosa neomexicana*: *2180*, July 24, 1911, Monticello, San Juan Co. On *Rosa aciculata* (Cockerell) Rydb.: *2166*, July 12, 1911, La Sal Mts., San Juan Co. On *Rosa* sp. nov.: *2217*, III, August 8, 1911, Scorup's pasture, Elk Mts., San Juan Co.

25. PUCCINIA CLEMATIDIS (DC) Lagerh. (*P. Agropyri* Ellis & Ev.)

On *Agropyron Palmeri* (S. & S.) Rydb.: *2184*, July 24, 1911, Monticello, San Juan Co. These plants were surrounded by an abundance of *Clematis ligusticifolia* heavily infected with the aecia. On *Agropyron tenerum* Vasey: *2204*, August 4, 1911, White Canyon, San Juan Co. Again in this collection there was an abundance of heavily-infected *Clematis* plants surrounding the *Agropyron*.

34. PUCCINIA CINEREA Arth.

On *Poa Wheeleri* Vasey: *2213*, Jack Spring, San Juan Co., July 30, 1911.

35. PUCCINIA CIRSII Lasch.

On *Carduus pulchellus* Greene: *2207*, August 8, 1911, White Canyon, San Juan Co. On *Cirsium oreophilum* Rydb.: *2168*, July 12, 1911, La Sal Mts., San Juan Co. On *Carduus oblanceolatus* Rydb.: *2168a*, July 12, 1911, La Sal Mts., San Juan Co. On *Cirsium Tracyi* Rydb.: *2186*, July 24, 1911, Monticello, San Juan Co. On *Carduus americanus* (A. Gray) Greene: *2171*, July 15, 1911, La Sal Mts., San Juan Co.

42. PUCCINIA CREPIDIS-ACUMINATAE Syd.

On *Crepis intermedia* A. Gray: *2208*, July 31, 1911, Elk Mts. near Bears' Ears.

44. PUCCINIA CURTIPES Howe

On *Saxifraga debilis* Engelm.: *2240*, August 18, 1911, Abajo Mts., San Juan Co.; alt. about 3,545 m.

45. PUCCINIA DOUGLASII Ellis & Ev.

On *Gilia pungens* (Torr.) Benth.: *2257*, August 24, 1911, Stage Station, Head Dry Valley, San Juan Co.; alt. 1,893 m.

47. PUCCINIA EFFUSA Dietel & Holw. I.

On *Viola adunca* Smith: *2154*, July 8, 1911, La Sal Mts. near Gold Basin, San Juan Co.

56. PUCCINIA GUTIERREZIAE Ellis & Ev. III.

On *Gutierrezia filifolia* Greene: *2188*, July 28, 1911, near Monticello, San Juan Co., alt. about 2,091 m.

58. PUCCINIA HELIANTHELLAE (Peck) Arth. II.

On *Helianthella arizonica*?: *2153*, July 7, 1911, La Sal Mts., near Gold Basin, San Juan Co.

64. PUCCINIA HOLBOELLII Hornem. III.

On *Draba Helleriana* Greene: *2158a*, July 9, 1911, Gold Basin, La Sal Mts., San Juan Co. On *Draba spectabilis* Greene: *2176*, July 17, 1911, Gold Basin, La Sal Mts., San Juan Co.

76. PUCCINIA MENTHAE Pers.

On *Mentha Penardi* (Briq.) Rydb.: *2229*, II, Aug. 14, 1911, Monticello, San Juan Co., alt. about 2,129 m. On *Monarda menthaefolia* Benth.: *2230*, August 18, 1911, Montezuma Canyon near Monticello, San Juan Co.

79. PUCCINIA MONTANENSIS Ellis. II.

On *Sitanion rigidum* J. G. Smith: *2205*, August 5, 1911, Armstrong Canyon above Edwin Natural Bridge, San Juan Co.

88. PUCCINIA POARUM Niessl. II.

On *Poa crocata* Mich.: *2241*, August 17, 1911, Abajo Mts., San Juan Co., alt. about 3,450 m. On *Alopecurus aristulatus* Michx.: *2185*, July 24, 1911, near Monticello, San Juan Co. On *Poa longipedunculata* Scribn.?: *2260*, August, 1911, San Juan Co.

96. PUCCINIA SHERARDIANA Körn.

On *Sphaeralcea marginale* York: *2195*, July 29, 1911, Allen Canyon, Elk Mts., San Juan Co. On *Sphaeralcea arizonica* Heller: *2222a*, Aug. 9, 1911, mouth of Dry Wash, San Juan Co. On *Malvastrum dissectum* (Nutt.) A. Nels.: *2181*, July 24, 1911, near Monticello, San Juan Co.: alt. about 2,121 m.

101. PUCCINIA STIPAE Arth.

On *Stipa comata* Trin. & Rupr.: *2203*, August 4, 1911, White Canyon, San Juan Co.

105. PUCCINIA SUBNITENS Dietel

On *Sarcobatus vermiculatus* (Hook.) Torr. Collected by Professor Marcus E. Jones on this host at Burbank, Utah, (alt. about 1800 m.), June 26, 1906. (M. E. Jones No. *7809*). Dr. Arthur has shown by cultures the relation of this *Aecidium* (*Aecidium Sarcobati* Peck) to *Puccinia subnitens.*

Since the publication of my last paper, culture work has also shown the connection between the *Aecidium* on *Atriplex hastata* and this *Puccinia.* (For reference to a collection of the aecial stage on *Sophia,* see No. 4 of this paper.)

109. PUCCINIA VIOLAE (Schum.) DC. I, III.

On *Viola canadensis* L.: *2245*, August 18, 1911, Abajo Mts., San Juan Co.

129. UROMYCES ASTRAGALI (Opiz.) Schröt. II.

On *Astragalus microlobus* A. Gray: *2237a*, August 11, 1911, Montezuma Canyon near Monticello, San Juan Co. On *Astragalus atratus arctus* Sheldon: *2146*. July 1, 1911, Moab, Grand Co. On *Astragalus argophyllus* Nutt.: *2089*, Aug. 26, 1909, Gogorza, Summit Co.

131. UROMYCES INTRICATUS Cooke. (*U. Eriogoni* Ell. & Hark.)

On *Eriogonum croceum* Small: *2198*, II, July 31, 1911, San Juan Co.

132. UROMYCES PROEMINENS Pas. (*U. Euphorbiae* C. & Pk.)

On *Euphorbia Fendleri* T. & G.: *2211*, August 6, 1911, White Canyon, Natural Bridge National Park, San Juan Co.

140. UROMYCES PLUMBARIUS Peck.

On *Oenothera montana* Nutt. (*Pachylophus montanus* (Nutt.) A. Nelson): *2177*, July 19, 1911, La Sal Mts., Grand Co.

145.* AECIDIUM CREPIDICOLA E. & G. Jour. Myc. **6**: 31. 1890

On *Crepis glauca* (Nutt.) T. & G. Given by A. G. Johnson as occurring in Utah in his paper "The Unattached Aecial Forms of Plant Rusts in North America" (No. 88, page 406).

146.* AECIDIUM OCCIDENTALE Arth. Bulletin Torrey Bot. Club 31: 7. 1904

On *Clematis Douglasii* Jones: I, collected by Mrs. Mary Strong Clemens, August 1, 1911, at Holiday Park, Uinta Mts.

147.* AECIDIUM sp.

On leaf of *Lappula caerulescens* Rydb. A single leaf affected by a very immature aecidium was collected by one of the writer's pupils in May, 1913. This was sent to Dr. Arthur for examination. He replied that sectioning had shown pycnia at least, and that no aecium was known on this host.

148.* COLEOSPORIUM RIBICOLA (C. & E.) Arth. (*Uredo Jonesii* Peck). N. A. Flora **7**: 86. 1907

On *Ribes inebrians* Lindl.: *2200*, August 2, 1911, Bears' Ears, Elk Mts., San Juan Co. Alt. about 2,583 m. *2253*. August 14, 1911, Montezuma Canyon near Monticello, San Juan Co. On *Ribes coloradense* Coville: *2252*. August 20, 1911, Innes' sawmill, Abajo Mts., San Juan Co., alt. about 2818 m.

149.* CRONARTIUM COLEOSPORIOIDES (Dietel & Holw.) Arth. N. A. Flora **7**: 123. 1907

On *Castilleja linariaefolia* Benth.: *2236*, August 14, 1911, Montezuma Canyon near Monticello, San Juan Co. Alt. about 2,076 m.

150.* CRONARTIUM COMANDRAE Peck, Bot. Gaz. 4: 128. 1879

On *Comandra pallida* A. DC. Collected by Mrs. Clemens Aug. 14, 1911, at Holiday Park, Uinta Mts.

151.* GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC. I. Fl. Franc. 2: 217. 1805

On *Amelanchier nana* Nutt.: *2247*, I. (*Roestelia lacerata* (Sow.) Fr.) August 19, 1911, Abajo Mts. near West Mountain, San Juan Co., alt. about 3,030 m. This is the first recorded collection of this species in the state.

152.* GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel, I, Bull. N. Y. Bot. Garden 7: 458. 1911

On *Philadelphus occidentalis* A. Nels.: *2227*, I. (*Aecidium gracilens* Peck). August 11, 1911, Dry Wash south of Abajo Mts., San Juan Co.; alt. about 2,348 m. The neighboring trees of *Juniperus monosperma* were abundantly affected with the galls of a defunct *Gymnosporangium*. The peridia of the aecia of this species are bright orange-yellow when first collected, but fade rapidly upon drying. This is the first record of the occurrence of the aecial stage of this species in the state. A record of the collection of the telia on *Juniperus utahensis* (Engelm.) Lemmon in Utah is given in N. A. Flora 7: 201. 1912.

153.* GYMNOSPORANGIUM INCONSPICUUM Kern, I, Bull. Torrey Bot. Club 34: 461. 1907

On fruit of *Amelanchier alnifolia* Nutt.: *2225*, August 11, 1911, Dry Wash near Abajo Mts., San Juan Co., alt. about 2,136 m. Several trees of fairly good size bore a profusion of fruit, and scarcely a single fruit had escaped infection. The material was in fine condition. Professor Charles P. Smith also collected very fine material of this in Dry Canyon, Cache County, on the same host, Aug. 8, 1909. Still another collection in my herbarium is that made by Mrs. Mary Strong Clemens, August 15, 1911, at the mouth of the Weber river.

On fruit of *Amelanchier utahensis* Koehne: *2226*, August 11, 1911, head of Dry Wash, near Abajo Mts., San Juan Co. Not so

abundant as on *Amelanchier alnifolia,* nor apparently so perfectly developed.

This aecidium was described by Kern as *Roestelia Harknessianoides.*

154.* MELAMPSORA ALBERTENSIS Arth. II, Bull. Torrey Bot. Club 33: 517. 1906

On leaves of *Populus tremuloides* Michx.: *2248,* August 19, 1911, Abajo Mts. near West Mountain, San Juan Co., alt. about 3,030 m. Dr. Arthur has confirmed by cultures that this rust has its aecia on *Pseudotsuga mucronata* (Arthur; Cultures of Uredineae in 1911—Mycol. 4: 58. 1912).

155.* PHRAGMIDIUM OCCIDENTALE Arth.; Earle, in Greene, Pl. Baker. 2: 3. 1901

On *Rubus parviflorus* Nutt.: *2246,* August 18, 1911, Abajo Mts. below Innes' sawmill. Alt. about 2,788 m. This rust has also been collected in Emigration Canyon, Salt Lake County.

156.* PUCCINIA ACROPHILA Peck Bot. Gaz. 6: 227. 1881

On *Synthyris laciniata* (A. Gray) Rydb.: *2136,* August 24, 1910, mountains above Lake Blanche, Big Cottonwood Canyon, Salt Lake County.

Mrs. Mary Strong Clemens collected the same species of rust on *Synthyris pinnatifida* Wats. at Mt. Minnie, Little Cottonwood Canyon, Salt Lake County, on August 16, 1911. The type was collected in Utah on the last-named host by Professor Marcus E. Jones.

157.* PUCCINIA ACTINELLAE (Webb) Syd. Monogr. Ured. 1: 4. 1904

On *Tetraneuris leptoclada* (A. Gray) Greene: *2201,* Aug. 3, 1911, rim-rock above Armstrong Canyon near Edwin Natural Bridge, San Juan County; alt. about 1,788 m.

158.* PUCCINIA ADOXAE DC. Flore Franc. 2: 220. 1805

On leaves and stems of *Adoxa Moschatellina* L.: *2239,* August 17, 1911, Abajo Mts., San Juan Co., at about 3,333 m. alt.

159.* PUCCINIA ALBULENSIS Magn. III, Ber. Deutsch. Bot Ges. 8: 169. 1890

On *Veronica Wormskjoldii* R. & S. (*V. alpina* Amer. Auct.): *736*, July 10, 1905, Alta Valley, head of Little Cottonwood Canyon, Salt Lake Co., at about 2,878 m. *855*, August 23, 1905, Big Cottonwood Canyon, 2,650 m. Not very common. Exsic. Fungi Utahenses *94*.

160.* PUCCINIA CIRCAEAE Pers. Roemer, Neues, Mag. 1: 119. 1794

On *Circaea pacifica* Aschers & Magnus: *2131*, August 19, 1910, Mill D, south fork Big Cottonwood Canyon, Salt Lake County.

161.* **Puccinia Clementis** Garrett, sp. nov. III.

III. Telia amphigenous (or rarely on stem or silique), not very numerous, scattered or occasionally confluent; roundish or elliptical, 1–5 mm. across; pulvinate; umber-brown; rather tardily naked, the ruptured epidermis plumbeous, usually easily discernible; teliospores $32–39 \times 15–19\,\mu$; the upper cell umbonate at the apex, the umbo as much as $2.6\,\mu$ long. Spores granular, and indistinctly striate, but slightly constricted at the septum.

Collected by Mrs. Mary Strong Clemens, Bald Mountain, Uinta Mts., on *Parrya platycarpa* Rydb., August 10, 1911.

162.* PUCCINIA COMMUTATA Syd. I, Monogr. Ured. 1: 201. 1904

On *Valeriana occidentalis* Heller. I (*Aecidium Valerianearum* Duby) was collected by Mrs. Mary Strong Clemens at Pharaoh's Glen, Parley's Canyon, August 4, 1911. The material was in especially good condition.

163.* PUCCINIA GLOBOSIPES Peck Bull. Torrey Bot. Club 12: 34. 1885

On *Lycium Andersoni* A. Gray. Collected by Professor Marcus E. Jones at Le Verkin, 909 m. altitude, and reported in his "Contributions to Western Botany" No. 7, page 730, 1895. I have not seen the specimens.

164.* PUCCINIA GRINDELIAE Peck Bot. Gaz. 4: 127. 1879

On *Chrysopsis Bakeri* Greene: *2223*, August 9, 1911, Dry Wash, San Juan Co.; alt. about 1,818 m.

165.* PUCCINIA GROSSULARIAE (Schum.) Lagerh. III, Ured. Herb. Fr. 60: 1895

On *Carex* sp.: *2221*, Aug. 8, 1911, near Kaigalia pasture, Elk Mts., San Juan Co.

166.* PUCCINIA KOELERIAE Arth. Mycologia 1: 247. 1909

On *Koeleria gracilis* Pers.: *2231*, Aug. 14, 1911, Montezuma Canyon near Monticello, San Juan Co., alt. about 2,076 m. In the original description of this rust, *Berberis aquifolius* is given as the host of its aecial stage.

167.* PUCCINIA MUHLENBERGIAE A. & H. Bull. Lab. Nat. Hist. State Univ. Iowa 5: 317. 1902

On *Muhlenbergia gracilis* H.B.K.: *2228*, August 11, 1911, head Dry Wash, near Abajo Mts., San Juan Co. On *Muhlenbergia Richardsonii* (Trin.) Rydb.: *2232*, August 14, 1911, Montezuma Canyon near Monticello, San Juan Co., alt. about 2,076 m. The aecium of this species is said to be found on *Callirrhoe involucrata* (Muhlenbergia, Jan. 1912, page 31).

168.* PUCCINIA OBLITERATA Arth. I, Mycologia 1: 250. 1909

On *Aquilegia caerulea* James: *2160*, July 11, 1911, head of Gold Basin, La Sal Mts., San Juan Co., alt. about 3,242 m. (In the original description of this rust, *Agropyron biflorum* and *A. caninum* are given as the hosts for the telial stage.)

169.* PUCCINIA PENTSTEMONTIS Peck, I, II, III, Bull. Torrey Bot. Club 12: 35. 1885

"On *Pentstemon confertus* var. *caeruleo-purpureus* Gray" (= *P. procerus* Dougl.) Collected by Marcus E. Jones, at Panguitch Lake, 2,520 m. alt.

170.* PUCCINIA PSEUDOCYMOPTERIDIS Holw. I, III, N. A. Uredineae 1[4]: 91. 1913

On *Pseudocymopterus montanus* (A. Gray) C. & R.: *2161*, I, July 12, 1911, near Gold Basin, La Sal Mts., San Juan Co. *2244*, I, III, Aug. 18, 1911, Abajo Mts. below Innes' sawmill. On *Pseudocymopterus Tidestromii* C. & R.: *2150*, July 5, 1911, La Sal Mts., San Juan Co. near Gold Basin.

171.* **Puccinia Rydbergii** Garrett, sp. nov. III.

Telia small, amphigenous, chestnut-brown, tardily pulverulent, surrounded by the ruptured plumbeous epidermis, often confluent. Teliospores cinnamon-brown, elliptical, rounded at both ends, $26–32 \times 16–18\,\mu$; germ-pore at apex of upper cell and near the base of the lower cell; pedicels hyaline, fragile.

On *Sedum stenopetalum* Pursh: *2152*, July 7, 1911, mountains above Gold Basin, La Sal Mts., San Juan Co.; alt. about 3,390 m. Collected by Rydberg & Garrett.

This species differs from *Puccinia Rhodiolae* B. & Br. mainly in the uniformly smaller spores.

172.* PUCCINIA SIEVERSIAE Arth. Bull. Torrey Bot. Club 31: 3. 1904

On *Sieversia turbinata* (Rydb.) Greene. Collected by L. N. Goodding (No. 1377), at Fish Lake, July 17, 1902.

173.* **Puccinia tardissima** Garrett, sp. nov. II, III.

II. Uredosori amphigenous, elongated, dull cinnamon-brown; uredospores spherical to elliptical, verrucose, yellowish-brown, $17–21 \times 21–23\,\mu$; germ-pores 4, scattered.

III. Telia like the uredosori, but darker; very rarely met with, the teliospores usually occurring mixed with the uredospores. Teliospores dark-brown, elliptical, $21–24 \times 25–35\,\mu$; their walls thin.

On *Arenaria* sp.: *2116*, Oct. 9, 1909, mountain-side south of Wasatch Resort, Little Cottonwood Canyon, Wasatch Mts. Type.

Also collected by E. Bethel in II only on *Arenaria subcongesta* (Wats.) Rydb., Aug. 23, 1907, at Ouray, Colo., and by E. T. & E. Bartholemew on *Arenaria congesta* Nutt., Aug. 30, 1913 (No.

5232), Yellowstone Park, Wyo. This latter collection shows the teliospores as sparse as in the collection made in Utah in October.

This species has been confused with *Puccinia modica* Holw., from which it differs especially in the very thin walls of the teliospores and in their sparse production.

174.* PUCCINIA TUMIDIPES Peck, Bull. Torrey Bot. Club **12**: 34. 1885

On *Lycium pallidum* Miers.: *2196*, July 31, 1911, Hammond Canyon, Elk Mts., San Juan Co., alt. about 1,434 m.

175.* PUCCINIA TURRITA Arth. Bull. Torrey Bot. Club **29**: 230. 1902

On *Saxifraga austro-montana* Wiegand: *2173*, July 15, 1911, La Sal Mts., San Juan Co., alt. about 3,272 m.

176.* PUCCINIA VARIOLANS Hark. Bull. Cal. Acad. Sci., p. 15, 1884

Mentioned in Arthur & Holway's Descriptions of American Uredineae, I, page 56, as having been collected in Utah on *Aplopappus spinosus* DC.

177.* UREDO CASTILLEIAE T. & E. Proc. Calif. Acad. **5**: 731. 1895

On *Castilleja affinis* H. & A. Collected by Professor Marcus E. Jones, July 19, 1894, Capitol Wash, alt. 1,500 m.

178.* UROMYCES AEMULUS Arth. Bull. Torrey Bot. Club **38**: 373. 1911

On *Allium acuminatum* Hook: *363*, June 3, 1904, Farmington Canyon, Davis Co., 1,700 m. alt. This species was found mixed with *Puccinia Blaisdalei* H. & A. in the collection reported in No. 80 of the writer's previous list. Dr. Arthur called attention to it in Mycologia **2**: 290. 1910.

179.* UROMYCES LYCHNIDIS T. & E. I, II, III, Proc. Calif. Acad. 5: 729. 1895

On *Lychnis Drummondii* (Hook.) Wats. Collected by Professor Marcus E. Jones, August 22, near Tate Mine above Marysvale.

180.* UROMYCES MYSTICUS Arth. Bull. Torrey Bot. Club 38: 377. 1911

On *Hordeum jubatum* L. Collected by S. M. Tracy (No. 712) at Provo. Date not given (according to Dr. Arthur, as stated in the original description).

181.* UROMYCES OBLONGUS Vize. I, III. Grevillea 5: 110. 1877

On *Trifolium Parryi* A. Gray: *2172a,* July 15, 1911, La Sal Mts., San Juan Co., alt. about 3,242 m. On *Trifolium scariosum* A. Nelson; *2172,* July 15, 1911, La Sal Mts., San Juan Co., alt. about 3,242 m., July 15, 1911.

182.* UROMYCES PSORALEAE Peck I, III, Bot. Gaz. 6: 239. 1881

On *Psoralea micrantha* A. Gray: *2144,* July 1, 1911, Moab, Grand Co., 1,212 m.

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ON A SMALL COLLECTION OF LICHENS FROM JAMAICA, WEST INDIES

R. Heber Howe, Jr.

In April, 1909, at the request of Dr. Duncan S. Johnson, of Johns Hopkins University, the New York Botanical Garden forwarded to me a small collection of lichens collected by him on the island of Jamaica in 1903 and 1906.

At the time I worked over and prepared this list, I was unable to find any recently published list[1] of the lichen flora of Jamaica, but the publication of Dr. L. W. Riddle's list[2] has led me to publish this enumeration. For the advantage of comparison, this list follows Dr. Riddle's arrangement.

Two specimens of the genus *Cladonia* were sent to Prof. Bruce Fink for determination: and the crustose species to Dr. H. E. Hasse; the genus *Stereocaulon* was sent to Dr. Riddle who has also determined several other specimens. Acknowledgment is here most gratefully made.

Pyrenocarpeae

Pyrenula "Lichen No. 7. Goat Isd. IV–16–06." A composite specimen.

Pyrenula "no spores"; *Porina* sp. (?). Spores "$28 \times 8\ \mu$."

Anthracothecium Mass. "Lichen No. 4. Goat Isd. IV–16–06." One specimen spores "muriform, pale-brown," Determined by Dr. Hasse. Nos. 1, 6, 8, 11, 31, 32, 37, and 100 and labelled "Lichens" belong in other groups.

Coniocarpineae

Sphaerophorus compressus Ach. "Lichen No. 36. Sir John, V–1–06." One specimen determined by Prof. Fink.

1 Swartz, Prod. 1788 and Flora Indiae Occidentalis, 1806.

2 Riddle, Mycologia, 4: 125–140. 1912.

GRAPHIDINEAE

Arthonia distendens Nyl. "Lichen No. 9 Goat Isd. (near Old Harbor), IV–16–06." The bark of this specimen supports several species, beside the above. Spores "40–60 × 24 μ, oblong and ovoid-oblong, colorless becoming light brown, 6–8 septate (7–9 locular) with several septations in longitudinal axis. Determined by Dr. Hasse. Other species present *Arthonia radiata* (Per.) Th. Fr. "no spores"; *Microglaena* "spores narrowly ellipsoid 23–32 × 10–14,4–7 μ septate and submuriform, decolorate becoming light brown"; *Microthelia* (?) *thelena* (Ach.) Mull. Arg. Spores "oblong-ellipsoid, 15–18 × 5–6 μ; *Thelotrema* (?) *lepadinum* Tuck. Spores "24–52 × 7–16 μ." Determined by Dr. *Graphis* "Lichens No. 5. John Crow Peak, IV–18–03." One specimen, "section *Diplographis,* but no spores seen." Determined by Dr. Hasse.

Chiodecton rubrocinctum Nyl. (= *Ch. sanguineum* (Sw.) Wain.) "Lichen No. 18. Clydesdale, IV–28–06." One specimen determined by Dr. Hasse.

Thelotrema (?) *subtile* Tuck., Determined by Dr. Hasse.

CYCLOCARPINEAE

Ocellularia alba (Feé) Müll. Arg. One specimen determined by Dr. Hasse. Spores "colorless roundish and ovoid-oblong, 3–4 septate."

Baeomyces absolutus Tuck. "Lichen No. 16, near Vinegar Hill (Trees), IV–23–03" and "Lichen 48 on *Eucalyptus* Whitfield Hall Wks. IV–22–03." Two specimens determined by Dr. Hasse No. 48 "contains a *Porina* also."

Cladonia rangiformis Hoffm. "Lichen No. 33, Cladonia sp.? Cinchona Hill, V–2–06." One specimen, determined by Prof. Bruce Fink.

Cladonia rangiformis var. *cubana* Wain. "Lichen No. 45, Blue Mt. Peak, IV–20–03, *Cladonia* sp." One specimen determined by Prof. Fink.

Cladonia didyma var. *rugifera* Wain. "Lichen No. 43, *Cladonia* sp. Clyde Valley, V–8–06." One specimen determined by Prof. Fink.

Cladonia aggregata (Sw.) Ach. "Lichen 34, *Cladonia* sp.? Cinchona Hill, V–20–06." One specimen determined by Prof. Fink.

Cladonia squamosa var. *phyllocoma* Rabenh. "Lichen 44, *Cladonia* sp. Clyde Valley, V–8–06." One specimen determined by Prof. Fink.

Stereocaulon ramulosum (Sw.) Ach. "Lichen No. 13, *Cladonia*, sp. Rd. to Morce's Gap (?)." Specimen determined by Dr. Riddle, of which a part is now in his herbarium.

Stereocaulon cornutum Müll. Arg. "Lichen No. 14, Morce's Gap, 03." One specimen determined by Dr. Riddle.

Leptogium tremelloides (L.f.) Gray. "Lichens No. 2, New Haven Gap, IV–30–03," and "Lichen No. 30, Sir John, V–1–06." Two specimens. Spores 28–32 × 14 μ. Determined by Dr. Riddle.

Leptogium phyllocarpum (Pers.) Nyl. "Lichen No. 19," and "20. Cinchona Hill, IV–28–03." Two specimens. Spores 28–40 × 10–18 μ. Verified by Dr. Riddle.

Leptogium "Lichen No. 3, Morce's Gap, IV–23–03." One sterile fragment is perhaps referable to some form of *chloromelum* (Sw.) Nyl.

Pannaria (*Parmeliella*) *pannosa* (Sw.) Delis. "Lichen No. 38, Portland Gap, IV–16–06," and "Lichen No. 39, Cinchona Hill, IV–28–03." Two sterile specimens. Dr. Riddle refers a part of this material to *P. Mariana* var *isideoidea* Müll. Arg.; a part to *P. rubiginosa* (Thurb.) Del., but in the absence of apothecia it is thought best to refer both to *Pannaria pannosa*.

Coccocarpia pellita (Ach.) Müll. Arg. "Lichen No. 10, Cinchona Hill, IV–25–06 (on soil)." One specimen spores 8 × 16 μ. Verified by Dr. Riddle.

Sticta Weigelli (Ach.) Wain. "Lichen No. 27, Cinchona Hill, IV–03." Determined by Dr. Riddle.

Sticta damaecornis (Sw.) Ach. Nos. 15, 17, 21, 22, 23, 29, 35, 41, and 42. Nos. 29, 35, collected in "V–06," all other in "IV–03," and representing in all the following localities: Blue Mt., Cinchona Hill, New Haven Gap, Latimer River, and Sir John. The specimens exhibit the wide variation in form of thallus location shown by this species. The envelopes in which the spe-

cimens came to hand were marked "Lichen," except "No. 29"—labeled "Liverwort." Spores $48 \times 16 \mu$.

Lobaria peltigera (Del.) Wain. "Lichen No. 40, Clyde Valley, IV–27–96." Spores $32–49 \times 14–16 \mu$. Determined by Dr. Riddle.

The Usneas of Jamaica present a very difficult problem because of the mass of described species from tropical and subtropical regions, which have been named with little or no correlated study of distribution. The determinations here made are not considered necessarily final, but are the best elucidation possible under the existing circumstances. Dr. J. A. Cushman of the Boston Society of Natural History has kindly allowed me to study, and here record, notes on the Usneas of a collection recently made by him in Jamaica. All his collecting was done in a different region of the island from that covered by Miss Cummings and Dr. Johnson, and his specimens seem to represent a flora less typically *tropical.*

Dr. Riddle writes me in connection with his determinations: "I was not at all satisfied with my dispositon" of the Usneas. We have since gone over all the material together, and there is very little doubt, as I have said, that the members of this genus from the tropics need a thorough revision.

Usnea [*Eumitria*] *implicata* Strt. "Lichen No. 24," and "25 Cinchona Hill, IV–28–03." Two small fertile specimens—spores normal. Also "Lichen No. 28, Sir John, V–1–96," sterile. Dr. Cushman's material from Newcastle and Mandeville represents this species in part. It is clearly defined by its hollow or arachnoid axis. Superficially it suggests *U. florida* (L.) Web.

Usnea dasypogoides var. *cladoblephara* Müll. Arg. "Lichen No. 26, John Crow, IV–18–93," and "Lichen No. 28, Sir John, V–1–96." This material appears to belong here. The type of this variety however, is not to be found among the Müller types either at Chambésy or at Kew.

The material No. 1*b* determined by Dr. Riddle as *Usnea laevis* (Eschw.) Nyl. is undoubtedly *U. arthroclada* Fée., which appears to be quite synonymous with *U. intercalaris* Wain. non? Kremp., *U. laevigata* Wain., and seemingly even *U. articulata* var. *di-*

morpha Müll. Arg. Nos. 7, 8 and 1*a* are referable to *U. Vrieseana* Mont. & Bosch.,[3] and are all *Pachynae,* as is Mr. Merrill's Lich. Exc. No. 109. No. 1*d* seems referable to *U. denudata* Smith (Rees, Encl. Arts. Sci Lit. 37: 1817), a naked, subpendulous plant of the *Mesinae* described from Otaheite. Nos. 2 and 6 (in part), as is Mr. Merrill's distribution Lich. Exc. No. 159, are dicroic[4] conditions of *U. ceratina.* One example of No. 6 is a typical *U. angulata* Ach. Dr. Riddle has kindly given me the following notes on *U. jamaicensis* Ach., made by him of the type preserved at Helsingfors. Though not as yet discovered in material examined from Jamaica it seems a fitting place to give its diagnostic characters. "It is a short rather stout plant, apparently erect, 4 cm. long and 1–13 mm. thick,—scabrous with copious, very minute papillae—much branched, but with very few fibrils—apothecia *frequent,* 1.5–3 mm. lat." Dr. Elfvring has also kindly sent me a fibril section which shows it to be a *Mesinae.* Dr. Wainio considered it synonymous with *U. aspera* (Eschw.) Wain.

The material collected by Dr. Cushman, not discussed above, seems to represent the following species. It was collected in March, 1912, at Catadupa (1,200 ft.), Montego Bay (up to 500 ft.), Mandeville (2,000 ft.), and Newcastle (4,000 ft.). In part it represents *U. concinna* Strt., and *U. radiata* Strt., both *Pachynae;* in part *U.* [*Eumitria*] *implicita* Strt. as mentioned above. The pendulous species are *U. angulata* Ach., not entirely typical, and a terete, robust species suggesting *U. longissima* Ach., but having a curious brown axis, and probably *U. mekista* Strt. One example of this material having the brown axis I am unable to name, and yet entirely unwilling, under the circumstances, to describe as new.

THOREAU MUSEUM OF NATURAL HISTORY,
CONCORD, MASSACHUSETTS.

[3] Since this paper was written, Dr. Yongman of Leiden has sent me for examination a part of the type of *U. Vrieseana.* It proves to be, instead of a *Pachynae,* as designated by Dr. Zahlbruckner, a *Leptinae,* and very closely allied, if not identical, with *U. articulata* (L.) Hoffm. These specimens are therefore probably to be referred to *U. gracilis* Ach.

[4] *U. rubescens* Strt.

NEWS, NOTES AND REVIEWS

Dr. W. H. Rankin, of the department of plant pathology of Cornell University, who has in recent years devoted considerable time to chestnut canker investigations, spent July 16–18 at the Garden consulting the mycological herbarium.

Another name for the fungus which often attacks the plane-tree in spring, causing its young leaves to wither, has been discovered by A. Tonelli, who concludes that *Microstroma Platani* Eddelb. & Engelke, as well as *Gloeosporium nervisequum,* is a stage of *Gnomonia veneta.*

H. von Schrenk, in the *Annals of the Missouri Botanical Garden* for May, 1914, describes a heart-rot of the mesquite in Texas caused by *Inonotus texanus* and a trunk disease of the common lilac in the vicinity of St. Louis caused by *Corolius versicolor.* Excellent plates accompany the descriptions.

A. Maublanc and E. Rangel have recently studied the fungous parasite of coffee known as *Stimblum flavidum* and have decided that it is the sterile form of a fungus to which they give the name *Omphalia flavida.* They find that the parasite easily spreads without the recurrence of the perfect form.

In a recent number of the *Journal of Agricultural Research,* W. H. Long gives very complete descriptions and illustrations of the heart-rot caused by *Aurantiporus Pilotae,* attacking oak and chestnut, and *Grifola Berkeleyi* and *Grifola frondosa,* attacking the base of the trunk and the larger roots of species of oak.

Dr. H. Hasselbring visited the Garden July 15 on his way to Europe. He was formerly engaged in mycological studies and is at present making extensive investigations into the cause of rot in

sweet potatoes. He finds that drying the potatoes quite thoroughly before storing them largely prevents decay.

Mr. Edward T. Harper continues his report on species of *Pholiota* in the region of the Great Lakes, in the *Transactions of the Wisconsin Academy of Sciences* for 1913. The plates used in illustration are not less handsome and attractive than in former papers. A number of species of *Stropharia* are also included in this report.

Mr. Simon Davis, in a recent number of *Rhodora,* gives an account of a large number of interesting gill-fungi collected by him at Stow, Massachusetts. Many of the species are rare and local. Mr. Davis intends now to turn his attention particularly to the genus *Inocybe,* and he will be glad to receive specimens for the study of this genus from any source.

The genus "*Muciporus*" is discussed by H. O. Juel in a recent number of the *Arkiv för Botanik,* the discussion closing with a list of the known species of the Tulasnellaceae, including *Gloeotulasnella* and *Tulasnella.* In a plate showing microscopic studies of *Polyporous corticola* Fries, *Tulasnella thelephorea* is shown to be the original of *Muciporus corticola.*

Miss Elsie M. Prior, in the *Journal of Economic Biology* for 1913, gives an account of her studies on the fungous disease of beech trees known as the "snap-beech" disease, which causes the trunk to break fifteen to twenty feet above ground. This disease is attributed to *Bjerkandera adusta,* which enters the tree by wounds and destroys the wood through the activity of enzyms.

Successful artificial cultures of *Clitocybe illudens* and *Armillaria mellea* on beef-malt-agar medium have been made by V. H. Young of the University of Wisconsin, who gives a brief description of his cultures in the *Botanical Gazette* for June, 1914. The fruit-bodies obtained in the first generation proved to be quite normal, but those in the second spore generation showed striking variations in form.

The temporary suspension of vitality in the fruit-bodies of certain hymenomycetes has been recently studied by A. H. R. Buller and A. T. Cameron, who conclude that dried fruit-bodies of *Daedalea unicolor* exposed in darkness to air at room temperatures are able to retain their vitality for at least seven years, and those of *Schizophyllum alneum* will remain alive under similar circumstances for nearly six years.

In the *Journal of Agricultural Research* for May, 1914, James R. Weir describes *Fomes putearius* and *Trametes setosus* as new wood-destroying fungi in the forests of the Northwest. The former is said to be closely related to *Pyropolyporus conchatus*, but always occurs on coniferous wood, with a preference for the larch; while the latter, occurring chiefly on *Pinus monticola*, seems to be most closely related to *Hapalopilus gilvus*.

Paul W. Graff reports several additions to the basidiomycetous flora of the Philippines in the *Philippine Journal of Science for* November, 1913, among them *Exidia lagunensis, Laschia philippinensis, Lentinus candidus, Lentinus lagunensis, Volvaria pruinosa, Naucoria malinensis,* and *Bovista Jonesii,* described by him as new. From a study of fresh specimens of *Hexagona luzonensis* Murrill, he concludes that this species belongs in the genus *Laschia* and transfers it to that genus.

In the *Annals of the Missouri Botanical Garden* for March, 1914, a paper appeared by Mr. L. O. Overholts on the Polyporaceae of Ohio, which listed about 100 species found within the state, of which 78 were collected by Mr. Overholts. Duplicates of most of these species were sent to the New York Botanical Garden for determination and verification and are now in the Garden herbarium. The paper contains descriptions of all the species listed, together with notes on their occurrence, hosts, and distinguishing characters. With the aid of this paper, students should find little or no difficulty in recognizing practically all of the pileate polypores of Ohio.

In the last number of the *Annals of the Missouri Botanical Garden,* E. A. Burt presents his first paper on "The Thelephoraceae of North America," which, we trust, will be rapidly followed by other much needed contributions to the knowledge of this important and difficult family. It will be a surprise to some, perhaps, to find *Exobasidium* among the twenty genera of the Euthelephoreae recognized by the author. The twenty-three known North American species of *Thelephora* are discussed in full, with synonyms, descriptions, and a list of specimens examined. *Thelephora scissilis* from the state of Washington, *T. magnispora* from Jamaica, and *T. perplexa* from Cuba are described as new.

An important collection of fungi from Texas, consisting of 100 numbers, collected by Dr. Fredrick McAllister assisted by students of the botanical department of the University of Texas, was recently sent in for determination by Professor I. M. Lewis, head of the department. Several of the more perishable species were accompanied by good field notes. Duplicates of nearly half of the collection were reserved for the Garden herbarium. These include *Inonotus texanus, I. juniperinus, Pyropolyporus texanus, Simblum sphaerocephalum, Calvatia craniiformis, Mycenastrum corium, Phellorina californica, Gyrophragmium texense,* and several species of *Tylostoma.*

A splendid collection of gill-fungi and polypores, containing nearly one hundred specimens accompanied by excellent field notes, was recently sent to the Garden for determination by Professor W. A. Setchell, of the University of California, who was assisted by the students and instructors of the department of botany in the collection and preparation of this material. This collection forms an important addition to the Garden herbarium and adds a number of new species to the list of known California fungi. A few of the specimens will probably prove new to science when the collection is more fully studied. Attention is called to the following species: *Agaricus californicus, Agaricus crocodilinus, Agaricus placomyces, Agaricus silvicola, Clitocybe oreades, Crepidotus calolepis, Crytoporus volvatus, Gomphidius oregonensis,*

Gomphidius vinicolor, Lepiota rhacodes, Pholiota candicans, Pholiota ventricosa, Stropharia ambigua, Tricholoma sordidum, and *Venenarius muscarius.*

The death of chestnuts and oaks due to *Armillaria mellea* is the subject of a professional paper recently published by W. H. Long, forest pathologist at Washington, after a special study of this disease near New Berlin, New York, and Brim, North Carolina, in both of which localities the chestnut canker is at present absent. He finds that *Armillaria mellea* can become an active parasite under favorable conditions, especially in chestnuts and oaks, killing not only suppressed trees in the forest, but also those that are growing under more favorable conditions; and he believes that this fungus has been an important factor in the gradual recession of the chestnut in parts of the southeastern United States.

In Oregon and the adjoining states, where *Armillaria mellea* attacks fruit trees to a considerable extent, Mr. H. P. Barss has recommended the removal of all affected dead roots and bark, disinfection with Bordeaux mixture or corrosive sublimate solution, and the covering of the wounds with paint or grafting wax.

A New Fungous Part of North American Flora

Volume 10, part 1, of NORTH AMERICAN FLORA, by William A. Murrill, containing descriptions of 281 species of the white-spored series of gill-fungi, appeared July 28, 1914. The contents of the part are indicated in the following table:

		Genera	Total Species	New Species
Clitocybe, in part	=	Laccaria	5	
Tricholoma	=	Melanoleuca	119	24
		Cortinellus	11	3
Pleurotus, in part	=	Pleurotus	1	
Armillaria	=	Armillaria	14	
Lepiota	=	Limacella	9	
		Lepiota	88	10
		Chlorophyllum	1	
Amanitopsis	=	Vaginata	7	
Amanita	=	Venenarius	26	2
			281	39

For the accommodation of those who desire to use currently accepted generic names, the following new combinations are proposed for species described as new or newly named in *Cortinellus, Limacella, Melanoleuca,* and *Venenarius:*

CORTINELLUS CINNAMOMEUS	= Tricholoma cinnamomeum
CORTINELLUS GLATFELTERI	= Tricholoma Glatfelteri
CORTINELLUS MUTIFOLIUS	= Tricholoma mutifolium
LIMACELLA ALBISSIMA	= Lepiota albissima
MELANOLEUCA ALABAMENSIS	= Tricholoma alabamense
MELANOLEUCA ANGUSTIFOLIA	= Tricholoma angustifolium
MELANOLEUCA AROMATICA	= Tricholoma aromaticum
MELANOLEUCA COMPRESSIPES	= Tricholoma compressipes
MELANOLEUCA EARLEAE	= Tricholoma Earleae
MELANOLEUCA EDURIFORMIS	= Tricholoma eduriforme
MELANOLEUCA FUMOSELLA	= Tricholoma fumosellum
MELANOLEUCA INOCYBIFORMIS	= Tricholoma inocybiforme
MELANOLEUCA KAUFFMANII	= Tricholoma Kauffmanii
MELANOLEUCA LONGIPES	= Tricholoma longipes
MELANOLEUCA MEMMINGERI	= Tricholoma Memmingeri
MELANOLEUCA NAUCORIA	= Tricholoma Naucoria
MELANOLEUCA ODORIFERA	= Tricholoma odoriferum
MELANOLEUCA PRAECOX	= Tricholoma praecox
MELANOLEUCA PRAEMAGNA	= Tricholoma praemagnum
MELANOLEUCA ROBINSONIAE	= Tricholoma Robinsoniae
MELANOLEUCA SUBACIDA	= Tricholoma subacidum
MELANOLEUCA SUBARGILLACEA	= Tricholoma subargillaceum
MELANOLEUCA SUBCINEREIFORMIS	= Tricholoma subcinereiforme
MELANOLEUCA SUBFULIGINEA	= Tricholoma subfuligineum
MELANOLEUCA SUBRESPLENDENS	= Tricholoma subresplendens
MELANOLEUCA SUBTERREA	= Tricholoma subterreum
MELANOLEUCA SUBTRANSMUTANS	= Tricholoma subtransmutans
MELANOLEUCA THOMPSONIANA	= Tricholoma Thompsonianum
MELANOLEUCA TOTTENII	= Tricholoma Tottenii
MELANOLEUCA UNAKENSIS	= Tricholoma unakense
MELANOLEUCA VOLKERTII	= Tricholoma Volkertii
MELANOLEUCA YATESII	= Tricholoma Yatesii
VENENARIUS LANEI	= Amanita Lanei
VENENARIUS ROSEITINCTUS	= Amanita roseitincta
VENENARIUS VIRGINIANUS	= Amanita virginiana

W. A. MURRILL

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ILLUSTRATIONS OF FUNGI

MYCOLOGIA

VOL. VI NOVEMBER 1914 No. 6

NORTH AMERICAN SPECIES OF ALEURIA AND ALEURINA

(WITH PLATES 142–144, CONTAINING 10 FIGURES)

FRED J. SEAVER

The genus *Aleuria* was founded by Fuckel, and originally comprised the two species *Aleuria aurantia* (Pers.) Fuckel and *Aleuria rhenana,* the latter species described by the author of the genus. The genus has been used in various ways but in recent years has come to be restricted by some writers to the reticulate-spored species of Pezizeae and in this sense it is here employed. Four such species are known to North America, all of which are characterized by the bright orange color of the hymenium with the whitish exterior. The habitats of the four species are quite distinct and three of these are shown in the accompanying photographs.

Aleurina was used by Saccardo as a subgenus of *Phaeopezia* and differs from *Aleuria* in that the spores are colored. While the reticulations in the spores of the type species are less distinct than in the various species of *Aleuria,* there is a strong resemblance between the markings of the spores of the various species of *Aleuria* and the type species of *Aleurina,* which is here regarded as a distinct genus. *Peziza retiderma,* which was made the type of Saccardo's subgenus, was originally described from material collected at Portland, Maine. Recent collections of this species at Portland, Connecticut, has furnished material for the accompanying illustrations and descriptions.

[MYCOLOGIA for September, 1914 (6: 221–272), was issued September 26, 1914.]

ALEURIA Fuckel, Symb. Myc. 325. 1869

Plants gregarious, scattered or cespitose, sessile or stipitate, fleshy, bright-colored, smooth or clothed externally with delicate white mycelium; asci cylindric, 8-spored; spores ellipsoid, at first smooth, at maturity reticulate.

Type species, *Peziza aurantia* Pers.

Spores not marked with ring at either end.
  Plants sessile, at maturity large, reaching a diameter of several cm. *A. aurantia.*
  Plants stipitate, medium-sized, seldom exceeding 1 or 2 cm. in diameter.
    Plants occurring in coniferous woods, stems usually long and springing from a dense mass of white mycelium............*A. rhenana.*
    Plants occurring among mosses in deciduous woods, stems short and not springing from a dense mass of white mycelium....*A. rutilans.*
Spores marked with a ring at either end.....................*A. bicucullata.*

ALEURIA AURANTIA (Pers.) Fuckel, Symb. Myc. 326. 1869

Elvela coccinea Schaeff. Fung. Bavar. 4: 100. 1774. Not *Elvela coccinea* Scop. 1772.
Peziza coccinea Bull. Herb. Fr. *pl. 474.* 1789.
Helvella coccinea Bolton, Fungi Halifax 3: 100. 1789.
Peziza aurantia Pers. Obs. Myc. 2: 76. 1797.
Otidea aurantia Massee, Fungus Fl. 4: 448. 1895.
?*Aleuria wisconsinensis* Rehm, Ann. Myc. 2: 34. 1904.

Plants gregarious or cespitose, at first globose, opening with a circular aperture and gradually expanding, at maturity varying in size from a few mm. to 5 or 6 cm. (rarely even larger), shallow cup-shaped and usually regular in form when young becoming irregular and often variously contorted with age, often from mutual pressure, rarely one sided and *Otidea*-like, occasionally discoid with the hymenium almost plane, bright-orange within, color fading in dried specimens, externally whitish-pruinose; asci cylindric or subcylindric, 12–15 μ in diameter and 175–250 μ long; spores 1-seriate, usually obliquely arranged in the ascus with the ends often overlapping, at first smooth and usually containing two (rarely more) large oil-drops, at maturity rough, roughenings taking the form of reticulations which are shallow and usually with one, rarely two, prominent projections at either end, 18–22 $\times$ 9–10 μ when mature, a little smaller when young; paraphyses strongly and rather abruptly enlarged above, often with the ends subglobose, reaching a diameter of 7 or 8 μ, filled with orange granules.

On naked soil in woods or open places, often on clayey soil.

TYPE LOCALITY: Europe.

DISTRIBUTION: Newfoundland to Washington, California and West Virginia; also in Europe.

ILLUSTRATIONS: Bolton, Fungi Halifax, *pl. 100;* Bull. Herb. Fr. *pl. 474;* Bull. Lab. Nat. Hist. State Univ. Iowa, **6**: *pl. 17, f. 1;* Cooke, Mycogr. *pl. 52, f. 203;* Fl. Danici *pl. 157;* Schaeff. Fung. Bavar. *pl. 148;* Sow. Engl. Fungi *pl. 78;* Boud. Ic. Myc. *pl. 313.*

EXSICCATI: Ellis, N. Am. Fungi *836;* Ellis & Ev. Fungi Columb. *15.*

ALEURIA RHENANA Fuckel, Symb. Myc. 325. 1869

?Peziza radiculata Sow. Engl. Fungi *pl. 114* (with descr.) 1797.
Peziza splendens Quél. Champ. Jura 388. 1872.
Sarcoscypha rhenana Sacc. Syll. Fung. **8**: 157. 1889.
?Sarcoscypha radiculata Sacc. Syll. Fung. **8**: 156. 1889.

Plants gregarious or cespitose, stipitate with the stems variable in length but reaching 1 or 2 cm., irregular, tomentose and attached by a dense growth of white mycelium which penetrates into the substratum binding together the leaves, twigs and leaf-mould in which they grow, the stems themselves often clinging together in clusters, abruptly expanding above into the cup which reaches a diameter of 1 or 2 cm. and about half as deep, exterior of the cup and stem white or whitish, the cups pruinose or subtomentose with poorly developed hair-like structures, hymenium bright-orange, color fading in dried specimens; asci cylindric above, tapering below, reaching a length of 300–350 μ and 15–17 μ thick, often becoming strongly spirally twisted at least in dried specimens; spores 1-seriate, obliquely arranged and often with the ends slightly overlapping, ellipsoid, at first smooth and with usually two large oil-drops, becoming rough, roughenings taking the form of reticulations with the meshes of the reticulations about 3 μ in diameter, rarely 5 or 6 μ, ridges extending 1–2 μ beyond the periphery of the spore, entire spore 23–27 $\times$ 12–16 μ; paraphyses enlarged above, about 6 μ in diameter, filled with orange granules.

On the ground in coniferous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: Pennsylvania to Alabama and west to Washington.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 314;* Cooke Mycogr. *pl. 112, f. 400.*

ALEURIA RUTILANS (Fries) Gill. Champ. Fr. Discom. 53. 1879
Peziza rutilans Fries, Syst. Myc. 2: 68. 1822.
Leucoloma rutilans Fuckel, Symb. Myc. 318. 1869.
Humaria rutilans Sacc. Syll. Fung. 8: 133.
Sarcoscypha albovillosa Rehm, Ann. Myc. 2: 33. 1904.

Plants gregarious or scattered, stipitate with the stem short, about 2 mm. thick and gradually expanding above into the cup and reaching a maximum length of about 5 mm., cup at first closed and of about the same diameter as the stem, gradually expanding and becoming turbinate with the margin more or less crenate and fringed, hymenium bright-orange, externally paler and tomentose, or with a few pale hairs about the margin of the cup, reaching a diameter of 1 cm. or occasionally larger; asci cylindric or subcylindric, gradually tapering below into a stem-like base, 300–350 × 20 μ; spores usually 1-seriate, obliquely arranged in the ascus with the ends overlapping, containing usually one or more, rarely two, large oil-drops and often several smaller ones, at maturity delicately reticulated, reticulations sometimes indistinct and broken, ellipsoid with the ends somewhat narrowed, 20–25 × 12–14 μ; paraphyses slightly enlarged above and densely filled with oil-drops and granules, about 4 μ in diameter at their apices.

On soil among mosses (especially *Polytrichum*), apparently growing on the dead leaves and often hidden by the living plants.

TYPE LOCALITY: Europe.

DISTRIBUTION: New Hampshire and New York to Iowa; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 315;* Grevillea 22: 108, *f. 1–6;* Bull. Lab. Nat. Hist. State Univ. Iowa 6: *pl. 17, f. 2.*

ALEURIA BICUCULLATA Boud. Bull. Bot. Soc. Fr. 28: 93. 1881
Peziza bicucullata Boud. Bull. Soc. Myc. Fr. 1: 103. 1885.
Humaria bicucullata Quél. Ench. Fung. 288. 1886.

Plants gregarious or crowded, at first subglobose, expanding and at maturity subdiscoid or often irregular from mutual pressure, 5 mm. to 1 cm. in diameter, at maturity pale-orange, externally a little paler and minutely roughened; asci cylindric above, reaching a diameter of 12–15 μ; spores obliquely 1-seriate and closely pressed together and showing a ring-like or hood-like process at either end on being separated, smooth and containing one or two oil-drops, at maturity strongly roughened, roughen-

ings taking the form of irregular and often broken reticulations, ridges of reticulations conspicuous and giving rise to rather sharp-pointed spine-like projections, terminal projections larger and giving the spore an apiculate appearance, entire spore 20–23 × 10–12 μ (including roughenings); paraphyses rather strongly enlarged above where they reach a diameter of about 5 μ.

On bare ground or among mosses.

TYPE LOCALITY: France.

DISTRIBUTION: Wisconsin; also in Europe.

ILLUSTRATIONS: Bull. Soc. Bot. Fr. 28: *pl. 3, f. 3;* Boud. Ic. Myc. *pl. 318.*

Aleurina (Sacc.) Seaver, gen. nov.

Phaeopezia § *Aleurina* Sacc. Syll. Fung. 8: 472. 1889.

Plants medium sized, cup-shaped, fleshy or subfleshy dark-colored; asci 8-spored; spores ellipsoid, at first hyaline, becoming smoky-brown, rough, roughenings often taking the form of indistinct reticulations; paraphyses stout.

Type species, *Peziza retiderma* Cooke.

Aleurina retiderma (Cooke)

Peziza retiderma Cooke, Mycographia 176. (1877.)

Phaeopezia retiderma Sacc. Syll. Fung. 8: 472. 1889.

Plants gregarious or occasionally cespitose, rather deep cup-shaped, regular in form or becoming irregularly contorted, irregularity often resulting from mutual pressure, at first brown and lighter externally, hymenium soon becoming darker and at maturity almost black, exterior also becoming darker but remaining lighter than the hymenium, reaching a diameter of 2–5 cm. at maturity; asci cylindric above, rather abruptly tapering below into a stem-like base, reaching a length of 275 μ and a diameter of 12–14 μ; spores 1-seriate, ellipsoid, at first hyaline, smooth and containing one or two oil-drops, gradually becoming roughened, smoky-brown, roughenings usually giving rise to one large protuberance at either end of the spore and irregular reticulate markings over the surface of the spore, the reticulate ridges so arranged as to give the spore a somewhat striate appearance, entire spore at maturity 15–17 × 10 μ; paraphyses strongly enlarged above, where they reach a diameter of 8 μ, minutely granular within and dilutely colored.

On the ground in woods often among mosses.

TYPE LOCALITY: Portland, Maine.

DISTRIBUTION: New York to Maine and Wisconsin.

ILLUSTRATION: Cooke, Mycographia, *pl. 79, f. 306.*

Aleurina aquehongensis sp. nov.

Plants gregarious or scattered, sessile, discoid to shallow cup-shaped, reaching a diameter of about 1 cm., externally slightly roughened, entirely brownish-black, with a slightly greenish tint to the hymenium which appears to be due to the spores which have dusted out of the asci; asci cylindric above, tapering below into a rather irregular stem-like base, reaching a length of 300–350 μ and a diameter of 15–17 μ; spores 1-seriate or occasionally slightly crowded, ellipsoid to subfusoid with the ends narrowed and containing one or two oil-drops, at first smooth, becoming rough, roughenings taking the form of irregular reticulations, mature spore $22–25 \times 10–12\,\mu$, hyaline, becoming pale smoky-brown, color more or less evanescent; paraphyses rather strongly enlarged above, reaching a diameter of 6 μ, pale-brown.

On the ground in a damp place.

Type collected by N. L. Britton and F. J. Seaver near Oakwood Heights, Staten Island, September 5, 1914.

DISTRIBUTION: Known only from the type locality.

EXPLANATION OF PLATES CXLII–CXLIV

PLATE CXLII

Upper figure, *Aleuria rutilans* (Fries) Gill. Photographed from material collected at Hudson Falls, New York, by Mr. Stewart H. Burnham.

Lower figures, *Aleuria rhenana* Fuckel. Photographed from material collected at Mill City, Oregon, by Dr. W. A. Murrill.

PLATE CXLIII

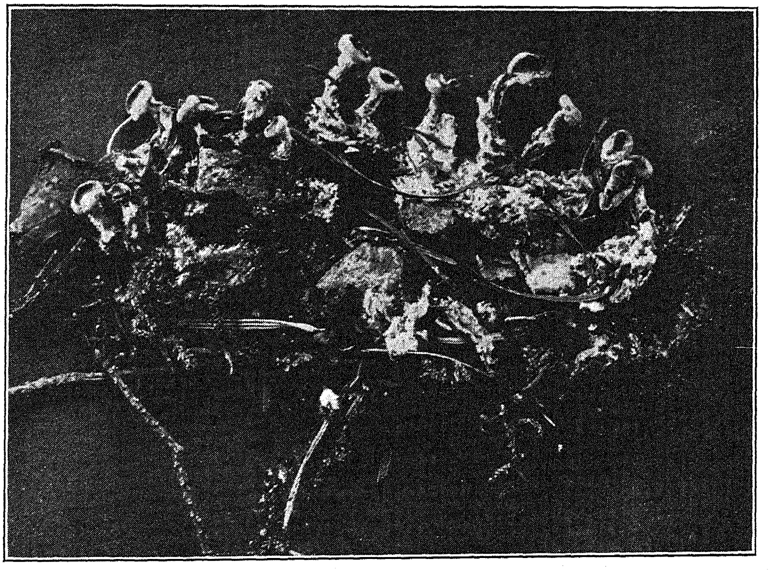
Upper figure, *Aleuria aurantia* (Pers.) Fuckel. Photographed from material collected in the New York Botanical Garden, by the writer.

Lower figure, *Aleurina retiderma* (Cooke) Seaver. Photographed from material collected at Portland, Connecticut, by the writer.

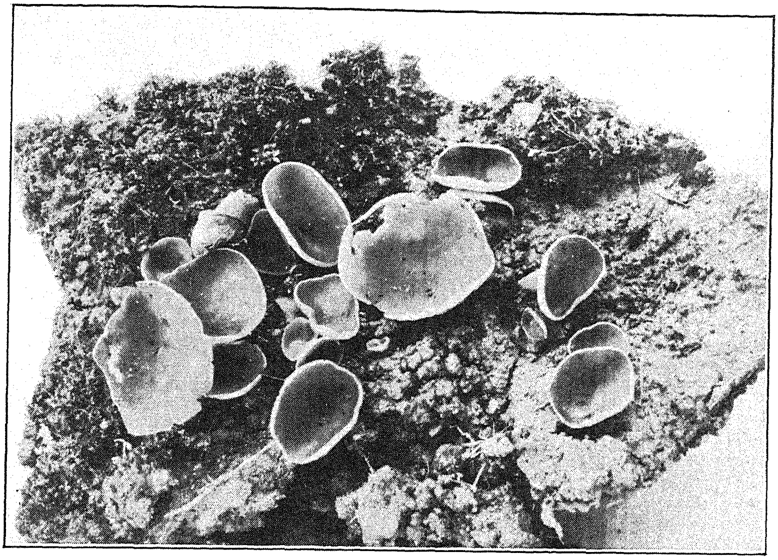
PLATE CXLIV

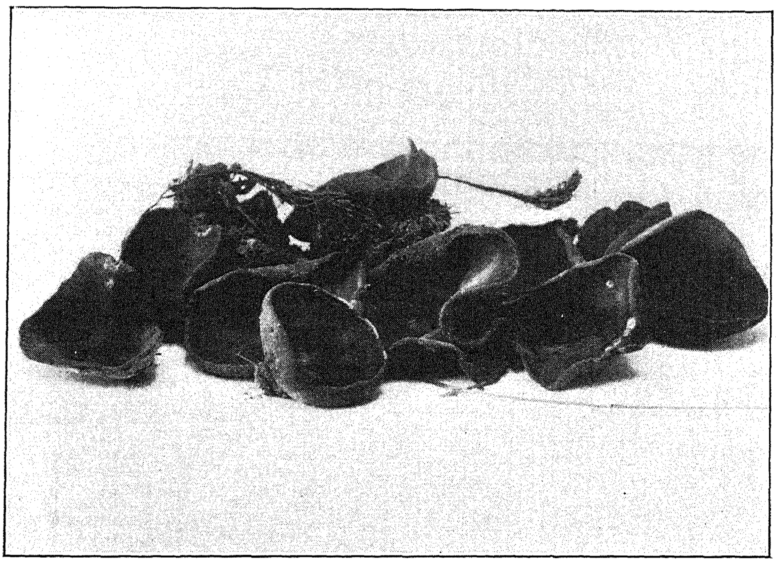
Spores and paraphyses drawn with the aid of the camera lucida to a common scale. Where the base of the ascus is shown, it is doubled back to save space.

1. *Aleuria aurantia* (Pers.) Fuckel.
2. *Aleuria rhenana* Fuckel. This drawing shows the spirally coiled base of the ascus as it often occurs in this species.
3. *Aleuria bicucullata* Boud.
4. *Aleuria rutilans* (Fries) Gill.
5. *Aleurina aquehongensis* Seaver.
6. *Aleurina retiderma* (Cooke) Sacc.

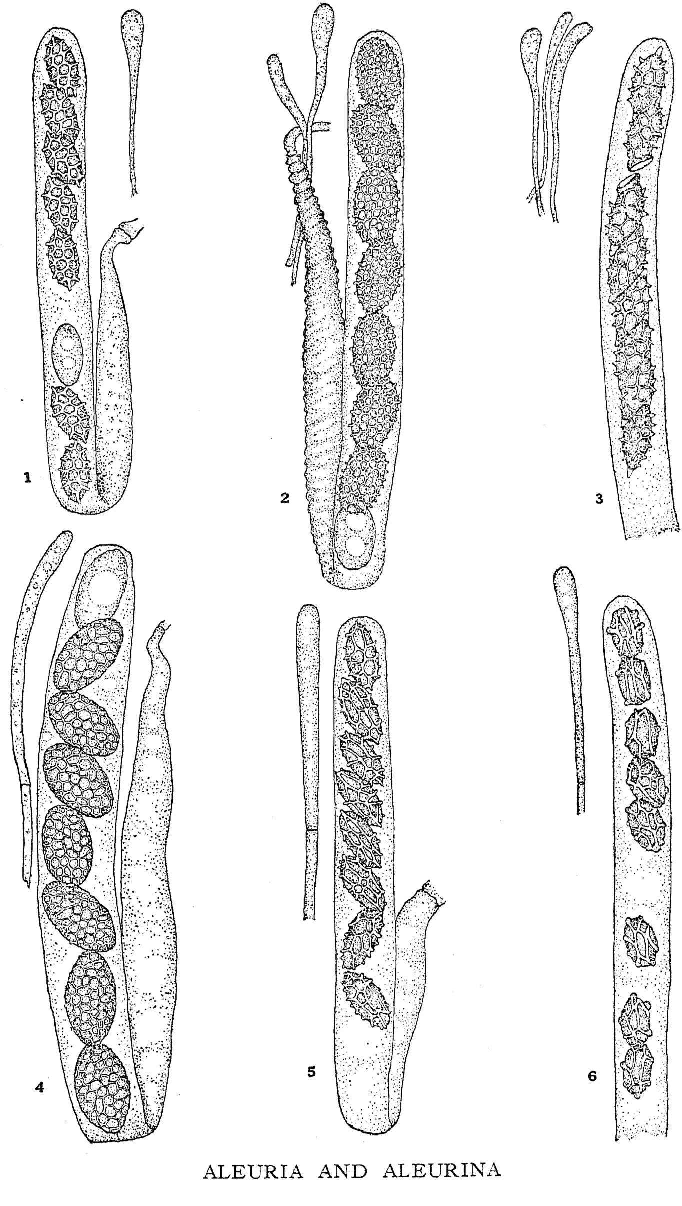


ALEURIA RUTILANS (FRIES) GILL.
ALEURIA RHENANA FUCKEL





ALEURIA AURANTIA (PERS.) FUCKEL
ALEURINA RETIDERMA (COOKE) SEAVER



ALEURIA AND ALEURINA

PARASITISM IN HYMENOCHAETE AGGLUTINANS

Arthur H. Graves

(With Plate 145, Containing 5 Figures)

Probably every one in the eastern United States who is interested in the fungi knows *Hymenochaete agglutinans* Ellis, at least by sight. The writer had been acquainted with it for many years before he knew its name, but, when its identity was once revealed, the aptness of its name made it unforgetable.

During the month of July, 1914, cases of disease directly due to the action of this fungus were observed, and the results of the investigation of these cases form the subject of the present paper.

While carrying on some experimental work in the woods at Mt. Carmel, Connecticut, the writer's attention was atracted by a small bush or tree which appeared to have been suddenly killed. The leaves, although still a dark-green, were withered and dry, and hung downward, presenting a sharp contrast to the surrounding healthy foliage. Thus, from a little distance, the symptoms were those of a sudden girdling of the plant, as, for example, from the work of an insect, or possibly as a result of mechanical injury. (Plate 145, figure 1.)

On examination, the plant was found to be a large spice bush [*Benzoin aestivale* (L.) Nees], with several main stems. One of these, the diseased shoot in question, was firmly bound to a dead trunk of alder [*Alnus incana* (L.) Moench.], which lay in an approximately horizontal position. The binding material was furnished by the fungus, *Hymenochaete agglutinans*, which, with the dead alder trunk as its source, had completely surrounded the spice bush stem and cemented it closely to the alder. Above this point of contact, with the exception of one short branch, the spice bush was entirely dead. (Plate 145, figures 1 and 4.) Further inspection revealed a young red maple (*Acer rubrum* L.) attached to the same dead alder in a similar manner, and also killed above the

point of contact. In the immediate vicinity, two branches of apple (*Pyrus Malus* L.) which had also come in contact with infected alders, had been killed in the same way.

That, in the case of the diseased spice bush, the dead alder was the source of infection, was proven by the fact that at many points along the alder trunk the fruiting bodies of the fungus appeared, in these cases being simply flat, more or less circular, blackish crusts. Moreover, where the trunk emerged from the soil, it was fairly covered with a crust of the same fungus, which was good evidence, when the parasitic tendencies of the fungus were definitely ascertained, that the alder had itself died from the attacks of the *Hymenochaete* at its base. The wood of the alder was quite soft, and evidently contained the mycelium of the *Hymenochaete* in great abundance.

As already stated, a casual glance might have inclined one to the belief that death in the case of the Benzoin had been sudden, but a more careful study of the parts above the girdled portion, and also of the fungus itself, proved that this was not the case.

First, a study of the growth in length of the various shoots above the infection showed conclusively that this part of the plant had been laboring under some difficulty for a considerable period. This may be seen from the following table:

TABLE I

COMPARATIVE LENGTH OF ANNUAL GROWTHS ON DISEASED PORTION

1912	1913	1914
8¾ inches	6 inches	2½ inches
10 "	6 "	3 "
9 "	4½ "	2½ "
9 "	11 "	5¾ "
7½ "	4 "	1¾ "
8¾ "	6¼ "	1¾ "

The shoots selected for these measurements represented the principal growths in length of this part of the plant, and in every instance but one they show a continually decreasing growth in length until death occurred in 1914. The growth of each shoot during 1914 was remarkably slight as compared with the normal growth of 1912, and the growth of 1913, except in one instance, shows a marked decrease.

On the other hand, a branch originating just below the earlier parts of the infection (Plate 145, fig. 4) showed corresponding increases in the growth in length of its main shoots, as may be seen from table II.

TABLE II

COMPARATIVE LENGTH OF ANNUAL GROWTHS OF BRANCH BELOW GIRDLED PORTION[1]

1912	1913	1914
2¼ inches	2½ inches	9 inches
	¼ inch	1½ "
	¼ "	1¾ "
1¾ "	1⅜ inches	3½ "

Again, examination of the fungus at the point of contact of the two plants showed periods of growth which could be correlated pretty well with the facts just mentioned. Apparently three years of growth were present, each one marked by a different color in the fungus. The growth of the first year, i. e., 1912, was black, that of 1913 a grayish hue, while the recent growth of 1914 was colored a creamy-yellow in the outer portions, shading into a deep rich-brown toward the inner parts. (Plate 145, figures 2 and 5.)

On the evidence presented by these observations, therefore, the girdling from the fungus first commenced in 1912. In the following year the effect of this girdling began to show itself in a marked decrease in the vigor of the year's shoots, a result which was enhanced by the continued development of the fungus. In 1914 the action of the fungus had progressed so far that the plant could make only a feeble growth, which soon died when all communication with the lower parts of the stem was shut off.

Microscopic examination showed clearly the presence of numerous hyphae among the living cells of the stem. For this study, sections were cut through the lower part of the region attacked, where it was partially overgrown with the fungus. (Plate 145, figures 2 and 5.) At this point, as would be expected, much of the stem was still alive. Yet the cambial region in many places had taken on a brownish color, and here, as well as in the living medullary ray cells of the wood, the presence of mycelium could be clearly demonstrated. A common mode of entrance of the

[1] As shown in Plate 145, Fig. 2, this branch had already, in 1914, become invested with the fungus and probably would have succumbed in its turn.

fungus into the stem was by way of the lenticels, and wedges of mycelium, using this means of ingress, could be easily made out in the bark.

It should also be mentioned that the piece from which the sections were cut was left with its lower end in water, and in a little more than a day a vigorous growth of mycelium had developed from the cut surface on the diseased portions. (Plate 145, fig. 3.)

There is therefore no doubt that *Hymenochaete agglutinans* is a facultative parasite. Yet the question at once arises, Why should it require two years to kill a small branch like that described above? In this connection we might recall the action of *Thelephora laciniata* Pers.,[2] a fairly close relative of *Hymenochaete*. For some time this fungus has been known to kill young plants by enveloping them with its mycelium and practically smothering them to death. It would appear that in the present case also a similar although more local effect of the fungus obtains. The close band of the fungus surrounding the stem becomes tighter and tighter as the stem grows in diameter, similar to the condition so familiar in the case of a vine twining around a stem. Moreover, as the fungus increases the area of its operations, the original band becomes hard and dry. It is significant also that the region where the fungus first encircled the stem is actually smaller in diameter than the part above. (Plate 145, fig. 5.) That this is not due to a thicker growth of the hymenium above, was proved by cross sections.

Such a condition, then, would produce a genuine girdling effect, resulting in weaker and weaker growth of the parts above, but increased growth of the parts below. Possibly not until the stem is thus weakened does the fungus commence its parasitism upon the tissues.

It might be argued that parasitism of the fungus alone could produce these symptoms, as indeed really happens in the chestnut bark disease. But if this were the case, death should ensue as soon as the stem is once girdled by the fungus, or very soon after. There is every indication, therefore, that here the parasitism of the fungus is supplemented by a mechanical, choking action.

[2] Hartig, R. Der zerschlitzte Warzenpilz, *Thelephora laciniata* Pers., Untersuchungen aus d. forstbot. Inst. 1880.

Hymenochaete agglutinans was described in 1874 by Ellis[3] as follows: "Of rather loose texture and of a light yellow color at first, becoming firmer and of a light tan color or rufous tint as the bristles are developed; closely adnate with a determinate margin, which is tomentose at first; forming orbicular or elongated patches or sometimes entirely surrounding the twig or limb on which it grows for an inch in length.[4] Common in autumn in swampy thickets on *Andromeda, Vaccinium,* etc., without much discrimination, fastening the stems or branches together wherever a dead twig or branch lies in contact with a living one: turns black and dries up during the winter."

Peck,[5] a few years later, reported the same species "on trunks and branches of living alder trees. Sandlake, and Adirondack Mountains." (New York.)

Saccardo,[6] in 1888, recorded the species, stating that it was indigenous to North America, and citing the collections of Ellis and Peck.

Later, Massee[7] included the species as indigenous to the United States in his monograph on the Thelephoreae, remarking as follows: "A well marked species, and certainly a genuine *Hymenochaete*. . . . Often completely surrounding twigs or cementing two together by growing continuously around both. Hymenium pale but often bright yellow, with ferruginous shades due to the setae."

We find the same species also recorded by Longyear[8] as common on oak limbs in Michigan.

A careful search through the literature has failed to disclose any definite record of parasitism in this species. Ellis' description, of course, points to such a relation where he speaks of fastening a dead twig or branch to a living one, and Peck also notes

3 Ellis, J. B. New species of fungi found at Newfield, New Jersey. Bull. Torrey Club **5**: 45–46. 1874.

4 The specimen on Benzoin measured about four and one half inches in length.

5 Peck, C. H. Ann. Rep. N. Y. State Mus. **30**: 47. 1878.

6 Saccardo, P. A. Syll. Fung. **6**: 602. 1888.

7 Massee, George. A monograph of the Thelephoreae. Part II. Jour. Linn. Soc. **27**: 95–205, pl. 5–7. 1891.

8 Longyear, R. O. A preliminary list of the saprophytic fleshy fungi known to occur in Michigan. Rep. Mich. Acad. Sci. **4**: 113–124. 1904.

it on living alder trees. Yet the statement that it actually kills the living branches is lacking.

A point of interest and practical importance is the fact that the fungus is apparently not particular as regards the selection of its hosts. We find that another species, *H. noxia,* exhibits this same characteristic. This species, common in tropical regions, has recently attracted considerable attention as an active parasite on tea, cacao, cotton, rubber, breadfruit, camphor, etc.[9]

Although we do not believe the disease caused by *Hymenochaete agglutinans* is at present of any economic importance, still it is conceivable that under certain conditions it might be capable of causing appreciable damage, as when plantations of young trees in moist localities are in close proximity to infected trees and shrubs, such as alder, *Vaccinium,* etc. Under such circumstances it would of course be advisable to cut out and burn the infected plants. Such work would entail the expenditure of only a few moments' time, and would probably save valuable trees from infection.

EXPLANATION OF PLATE CXLV

FIG. 1. Photograph showing diseased *Benzoin aestivale* in its natural environment. Dead horizontal trunk of alder in the foreground, the point of contact of spice bush and dead alder a little below the center of the picture. Above this point, the withered, dead portion; and a little to the right, vigorous young shoots which have developed from the base of the plant.

FIG. 2. Photograph showing *Hymenochaete agglutinans* originating in the dead alder trunk, and surrounding the stem of the spice bush. The annual growths of the fungus, or rather, the hymenium, are shown; the first, a semicircular patch to the left of the spice bush, and surrounding it; the second, extending nearly to the lateral branches above and below the point of contact, and the third, of a lighter color, to points beyond the branches. × 1/8.

FIG. 3. Photomicrograph of spice bush stem cut transversely a little below the insertion of the lower lateral branch in Fig. 2. Showing mycelium on the cut surface, grown out after the piece had been left with its other end in water for about two days. The fungus is especially active in the bark, the region of the cambium being shown by the dotted line. × 5.

FIG. 4. Photograph of diseased spice bush and part of alder trunk brought into the laboratory. The healthy green leaves wilted during transportation.

FIG. 5. Same as figure 2, enlarged. × 2/5.

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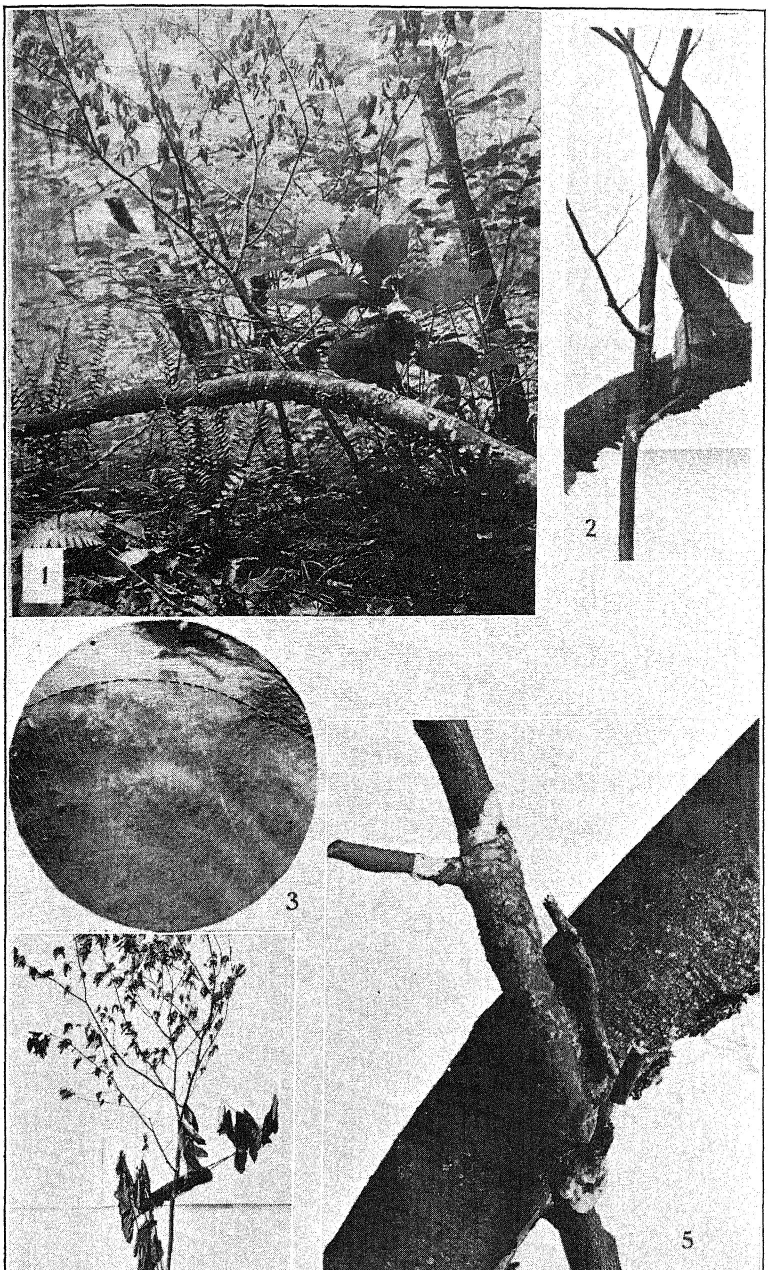
9 Cook, M. T. Diseases of tropical plants. London, 1913.



HYMENOCHAETE AGGLUTINANS ELLIS

TWO NEW SPECIES OF WATER MOLDS

(With Plates 146–148, Containing 38 Figures)

W. C. Coker

Since the publication of my third new species of *Achlya*[1] in 1912 a continued study of the occurrence and periodicity of the Saprolegniaceae in Chapel Hill, has discovered two other new and remarkable forms of that family.

The first of these was met with as long ago as March, 1911, and it has been found twenty-five times since. Pure cultures on various media, generally from a single spore, have been kept under observation for over three years. So puzzling is the form that after preparing a description of it in 1912 it was decided to continue collections and experiments for another year before publication. The difficulty arises from the fact that our plant combines in a most confusing manner the characters of both *Achlya* and *Saprolegnia*, and a rigid interpretation of these genera as at present defined would exclude it from both. As the formation of a new genus in such a case could not simplify matters, and as the genera *Achlya* and *Saprolegnia* are sufficiently distinct except for this narrow point of contact, it would seem much better to retain them and admit the variations. The case is not unlike the situation in the two genera *Puccinia* and *Uromyces*, where forms are known that combine the characters of both. As the proliferation of the sporangia is usually of the *Achlya* type I have decided to refer this form to the genus *Achlya* and to define it as follows:

Achlya paradoxa sp. nov.

Plant delicate; hyphae straight, slender, and little branched, the larger threads having a diameter of about 37 μ; many much smaller, the average being about 10–15 μ; sporangia plentiful at all stages, narrowly club-shaped and largest at the distal end which is about 55 μ in diameter, rounded, and furnished with a distinct but short papilla; secondary sporangia formed usually

[1] Mycologia 4: 325. 1912.

by cymose branching beneath the old ones, but occasionally also by proliferation through the empty ones, exactly as in *Saprolegnia*. Spores formed in several rows as in *Saprolegnia* and *Achlya*, on emerging all ciliated, but varying greatly in behavior—some swimming away as a rule, others remaining attached to the tip of the sporangium; oogonia produced on the tips of short lateral branches, usually near the base of the main hyphae, sometimes intercallary; their walls smooth and without pits, except for the thin places where the antheridia are attached; oospores usually two, often four and rarely one or eight; their diameter from 22 to 37 μ, averaging about 30 μ; antheridia always present, generally several on each oogonium, short club-shaped and terminating slender branches of diclinous origin which show a decided tendency to twine about the oogonial branches; antheridial tubes enter the oogonia, run among the eggs, and probably fertilize them.

In fig. 1 the sporangia are shown in a group after the manner of *Achlya*. The bending of the sporangia that is quite noticeable in this figure is characteristic, though not always so pronounced.

In figs. 2 and 3 are shown the proliferation of sporangia by both the *Achlya* and *Saprolegnia* methods on the same thread. The latter method is rare, but when it does occur is exactly as in *Saprolegnia* a condition that has not been observed in any other species of *Achlya*. In fact I know of no reference in the literature to internal proliferation of any kind in *Achlya* except by Peterson[2] who says: "Thus I have seen zoosporangia which had proliferated in undoubted species of *Achlya*."[3] The behavior of the spores on emerging is remarkable and very variable. In regard to their action I shall give the following quotation from my notes made at the moment of observation:

The spores emerge somewhat elongated and may be seen to bend backward at the ends and fuse into a pear-shaped spore, as is the case in *Leptolegnia*. The spores are very sluggish and most of them fall down immediately around the sporangium mouth and encyst, also a lot are often left in a group that sticks to the sporangium mouth, giving the effect of *Achlya*.

I find cases where all, or nearly all, of the spores group themselves at the mouth exactly as is typical for *Achlya*. When conditions are unfavorable the spores sometimes do not emerge at all and in such cases they sprout in position.

Noticed two sporangia empty near together. In one the spores grouped themselves at the mouth of the sporangium just as in *Achlya*, except that a

[2] Ann. Mycologici **8**: 520. 1910.

[3] The extreme rarity of such a phenomenon in *Achlya* would make it desirable that such an observation be accompanied by figures.

few of the outermost gently rocked themselves away a little distance from the main mass and then settled down. The spores that remained in a mass at the tip of the sporangium also showed a very slight rocking movement, thus proving the presence of cilia, but in a couple of minutes they became quite still. In the other sporangium the spores charged out with great rapidity and everyone dashed rapidly away.

A sporangium emptied at 11:13 and all the spores sank slowly to the bottom of the dish separating themselves considerably by a gentle rocking motion. After settling, individuals would move spasmodically at intervals, turning and jerking, but none swam actively or any distance. This interrupted movement continued for at least a half hour after emergence.

The existence of cilia thus indicated by the behavior of the spores was demonstrated by treatment with potassium iodide solution at the moment of emergence. A sporangium so treated is shown in fig. 4. All the spores can be distinctly seen to have cilia. From these observations it will be seen that the behavior of the spores in *Achlya paradoxa* has no parallel in the genus.

In figs. 5, 6, 7, 8, a series of oogonia are shown with normal variation. Oogonia without stalks and with their bases formed from a section of a hypha are not at all rare (fig. 5.) The variation in size of the oogonia is extreme. The smallest are not more than 23 μ in diameter, the largest may reach 74 μ.

Slender upgrowths into the oogonium from the partition below are occasionally seen. Such growths often appear in other species of *Saprolegnia* and *Achlya*, but, while they give the effect of antheridial tubes, they are usually quite functionless. The antheridia themselves are peculiar. They are sudden enlargements of the tips of the antheridial branches and are short, thick and tuber-like. They often proliferate, and usually by growth from near the base of the antheridial cells themselves. These outgrowths are then cut off as separate antheridia (figs. 7 and 8). When first formed the antheridia are well filled with protoplasm and contrast strongly with the almost colorless branches that bear them. Later the antheridia appear almost empty as if they had discharged their contents into the eggs. This, however, was not actually observed. Chlamydospores unlike the oogonia, are not rare, but appear plentifully, though not densely, in almost all cultures. The majority terminate short branches and approximate the oogonia in size, shape and position (fig. 9): others are arranged in chains (fig. 10) which are usually curved or contorted.

Elongated and irregular forms are also produced from somewhat swollen and knotted segments of the hyphae.

Under ordinary cultural conditions such as on flies, ant larvae, gnats, mushroom grubs, etc., in water there is usually no sexual reproduction. Out of a hundred cultures perhaps one would show a few oogonia. A number of experiments have been made to induce the formation of oogonia. The results of some of these are as follows:

On a bit of whole egg agar in distilled water: Growth vigorous and healthy. Sporangia abundant, emptying normally and proliferating laterally from below. No oogonia or chlamydospores.

On a bit of whole egg agar in distilled water: Growth vigorous, reaching a diameter of 4 cm. Sporangia slow to form, but after full growth appearing rather plentifully. Chlamydospores of usual shape present, but not plentiful. No oogonia.

On a bit of hard boiled egg yolk in distilled water: Growth vigorous, reaching a diameter of 4 cm. Sporangia abundant and formed earlier than in culture above. Chlamydospores plentiful. Oogonia present, but scarce. Antheridia of diclinous origin. As this was a culture from a single spore, the presence of antheridia proves that the plant is not dioecious.

On a bit of whole egg agar in spring water: Growth vigorous and strong. Many chlamydospores. No sexual reproduction.

On fly in spring water: Growth vigorous. Many sporangia, all proliferating from side below as in *Achlya*. No chlamydospores or oogonia.

On corn meal agar: Growth extensive, filling dish. Aerial branches nearly reaching cover, but not dense. Only chlamydospores present.

In 5 per cent. maltose + 0.1 per cent. peptone solutions mixed half and half: Growth vigorous and healthy. A few small sporangia were formed, but the spores were only imperfectly discharged. Also a few of the characteristic knob-like chlamydospores.

On corn meal agar in tightly stopped sterile bottle: Growth vigorous, extending across bottle and making a mold-like aerial growth an inch high. On examination there were found only single chlamydospores, most of which were quite empty, they having sprouted by a slender thread about 3 μ in diameter. In fact all the growth was remarkably slender (3 μ in diameter), enlarging to normal size only just below the chlamydospores.

On corn meal and egg yolk agar: Growth very strong, covering dish and developing abundant aerial hyphae that reach the cover. No reproduction of any kind.

The following six cultures were all made on ant larvae in distilled water with the salt added as indicated:

In 0.1 per cent. KNO_3: Growth good. Normal sporangia, discharging and spores taking second swim. Many good chlamydospores of usual shape, the larger ones having a tendency to form the cross wall some way up from the base. No sexual reproduction.

In 0.1 per cent. KH_2PO_4: Growth good. Many normal sporangia discharging, and spores taking second swim. Many chlamydospores. No sexual reproduction.

In 0.1 per cent. Na_2HPO_4: Growth good. Many normal sporangia discharging, and spores taking second swim. A good many chlamydospores, but not so numerous as in the preceding cultures. No sexual reproduction.

In 0.1 per cent. K_2SO_4: Growth slight. Culture infested with fungus. Sporangia formed but not discharging. A few chlamydospores. No sexual reproduction.

In 0.1 per cent. $Ca_3(PO_4)_2$: Growth good. Many normal sporangia discharging, and spores taking second swim. Many chlamydospores of usual shape. No sexual reproduction.

In 0.1 per cent. $Ca(NO_3)_2$: Growth good. Many normal sporangia discharging, and spores taking second swim. Many chlamydospores. No sexual reproduction.

The following seven cultures were all made on hard boiled egg yolk in distilled water with the chemical added as indicated:

In 0.1 per cent. KNO_3: Strong growth. No sporangia. A few good chlamydospore. No sexual reproduction.

In 0.1 per cent KH_2PO_4: Growth good. A very few sporangia with normal discharge. No chlamydospores or sexual reproduction.

In 0.1 per cent. Na_2HPO_4: Strong growth. Abundant sporangia proliferating repeatedly, and discharging normally. A very few chlamydospores. No sexual reproduction.

In 0.1 per cent. K_2SO_4: Strong growth. Sporangia plentiful. Chlamydospores abundant. No sexual reproduction. One sporangia was seen discharging. The emergence was rather slow, and the last few spores were very slow and showed obvious swimming movements in the sporangium on escaping. About a dozen clung to the tip of the sporangium. The others spread in a loose flock, showing slow movements, and every now and then one would swim briskly away.

In 0.1 per cent. $Ca_3(PO_4)_2$: Strong growth. Many sporangia, quite normal. A very few chlamydospores. No sexual reproduction. Several sporangia seen to discharge. Six spores detached themselves at different points and moved away, soon stopped and settled to the bottom. All others remained attached in a pretty solid mass to the tip of the sporangium. In another case four were detached. In another case six were detached.

In 0.1 per cent $Ca(NO_3)_2$: Very little growth. A good many chlamydospores. Nothing else.

In 0.1 per cent. K_3PO_4: Strong growth. Abundant sporangia. Many good chlamydospores that look exactly like oogonia initials, and a good many smaller branches that suggest antheridial branches, but no oogonia.

The genus *Pythiopsis* has until now included but one species, *P. cymosa,* discovered in Germany by De Bary.[4] It has been recognized only one since, it seems, when Humphrey[5] found it

4 Bot. Zeit. 46: 63. 1888.

5 The Saprolegniaceae of the United States. Transactions Amer. Philos. Soc. 17: part 3.

at Amherst, Mass. From two figures given by Hine[6] I am inclined to think that he had before him the sporangia of this plant, but that was before it had been described, and he did not get any further with it. I have found this species a good many times in Chapel Hill in springs, brooks and marshes; for example, in Terra Cotta Spring, Glen Burnie Farm (Jan. 15, 1913), twice in a marshy place near the above spring (once on Jan. 15 and again on Jan. 30, 1913), in Howell's Spring (Jan. 7, 1914), in Howell's spring and the brook below (March 3, 1914), etc. As the plant has so far been rather inadequately figured and described I shall give a short account of it before describing the new species. The sporangia, oogonia and antheridia are well shown by De Bary and Humphrey, but variations occur that were not observed by them. The antheridial cells, as formed in about one half the oogonia are unique in position. They arise by the enlargement of the hypha immediately below the oogonium and the growth of this segment along the base of the oogonium for a short distance. A tube is formed near the septum and enters to the egg. As the antheridial cell is in close contact with the oogonial wall from the septum out, the position of the septum becomes obscured and the oogonium seems to be seated at maturity on a large, swollen, basal cell. Under high power, however, the original septum may be seen as a somewhat thicker disc. This form of antheridium, as shown in fig. 1 and in one of the two in fig. 2, is not exactly illustrated in either De Bary's or Humphrey's figures. From this strictly basal and closely pressed antheridium we have in the remaining half of the oogonia all sorts of variations. The antheridium may be elevated on a stalk that varies from nothing to half the length of the oogonium and in very rare cases the antheridium may be even of diclinous origin (figs. 5 and 6). The appearance of several antheridia on one oogonium is of rather frequent occurrence in my cultures. This is not recorded by De Bary or Humphrey. From figures 3 to 7 an idea may be gained of the variations observable in both antheridia and oogonia. De Bary does not give the size of the oospores. I find them to vary from 16.5 to 24 μ, with an average of about 19.5 μ. This is a little larger than the figures given by Humphrey.

[6] Figs. 6 and 7, plate 5, Amer. Micr. Journal 1. 1878.

The remarkable intercalary oogonium shown in fig. 8 is unique. Its single egg was 27.8 by 50 μ in size and a large number of oil-drops were grouped at each end. An antheridial cell was also cut off at each end, but no antheridium could be made out.

The peculiar jelly-like outer layer that De Bary noticed on the oogonia in October cultures was also seen by Humphrey in a few cases. By careful observation I have been able to make out this layer in the majority of young oogonia. It is probably present on all at a certain stage, but in clean cultures free from bacteria is very hard to trace. Its presence and outline is hardly discernable, except for the bacteria and other minute particles that stick to it. As remarked by Humphrey it is hardly possible that this hyalin gelatinous outer sheath can be a "periplasm" secreted from the oogonium contents, as De Bary suggests. It is more apt to be due to the gelatinization of a thin outer layer of the wall of the oogonium.

In a typical clean culture in springwater on a mushroom grub the sporangia varied from 37 to 56 μ in diameter, the majority being from 44 to 48 μ broad.

In figures 9 and 10 are shown sporangia of usual appearance. When the sporangia proceed at once to the formation of spores the discharge is usually at the tip (fig. 9). If a rest occurs, the immergence tube is as apt to appear at the base, as shown in fig. 11. After the first sudden release of pressure the spores do not rush out as in *Achlya* and *Saprolegnia,* but emerge much more quietly as they find the opening. The last ones often swim around a long time in the sporangium before finding an exit. The spores are pear-shaped, with two cilia at the small end. On coming to rest they round up. In fig. 12 are shown three normal spores and an anomalous double one with four cilia. This is not a case of fusion after emergence, but of imperfect segmentation of the protoplasm. I have often seen in species of *Achlya* the discharge of large lumps and iregular masses of protoplasm from the sporangia as a result of imperfect segmentation. Sometimes the whole mass may in *Achlya* be thus discharged as a single long, contorted rope (see below p. 300). Leitgeb[7] shows similar masses of protoplasm in *Saprolegnia monoica* (under the name of *Diplanes*).

[7] Jahrb. für Wiss. Bot. 7: 357, plate 24, figs. 3–5. 1869.

Resting bodies of more or less globular shape are formed in quantity and are often arranged in chains (fig. 11). After a rest these also form zoospores.

Our new species of *Pythiopsis* has appeared eight times in collections made in the neighborhood of Chapel Hill. It was first obtained on Feb. 29th, 1912, from collections made at intervals along the brook that flows from the spring about 100 yards to the northwest of Dr. Archibald Henderson's residence. A tumbler of water was taken at each place with a little mud and any algae and dead leaves, twigs, etc., that happened to be present. Ant larvae were floated on the surface of the water of each tumbler and in four of these appeared a species of *Pythiopsis* that was found to be new. It was also found on the same day in a springy marsh on the south side of Glen Burnie Meadow and appeared subsequently in the brook in Battle's Park (March 18, 1912), in the branch south of the South Building, U. N. C. (March 25, 1912), and again in the Glen Burnie Meadow Marsh (May 13, 1912). The plant was separated from other fungi present and was grown in pure cultures for about six months. I have named the species in honor of the late Dr. James Ellis Humphrey, author of "*The Saprolegniaceae of the United States,*" whose work has been of great assistance to all students of this group in America. The species may be defined as follows:

Pythiopsis Humphreyana sp. nov.

Vegetative growth of long, slender, sparingly branched hyphae of about 11 to 14 μ in diameter throughout, stouter in the neighborhood of the reproductive bodies, after maturity disorganizing rather quickly; sporangia varying in shape from spherical, oval or pyriform to elongated, tapering and irregular forms, discharging by a short or rather long papilla and usually proliferating from below in a cymose manner; spores monoplanetic, pear-shaped and with two cilia, about 8.9 μ in diameter on coming to rest; oogonia generally borne exactly like the sporangia and not to be distinguished from these when young, apical and often in groups by cymose branching, usually spherical with a basal neck, sometimes pear-shaped and rarely longer and more irregular, varying greatly in size, diameter from 33 to 89 μ, averaging about 43 μ; wall always smooth and unpitted, about 1.4 μ thick; oospores generally one, occasionally two and very rarely four, centric,

diameter from 24 to 40 μ averaging about 30 μ, the wall about 2 μ thick, not so nearly filling the oogonium as in *P. cymosa;* antheridia short-clavate, terminating a stalk that usually arises from immediately below the oogonium, but sometimes of more distant origin, or rarely diclinous, one, two or occasionally more on every oogonium and generally applied to its top or distal half, with an antheridial tube which reaches and apparently fertilizes the egg; resting bodies resembling sporangia or oogonia present in quantity, after a rest forming spores or germinating with tubes.

The species is sharply separated from *P. cymosa* by the much larger and always smooth oogonia, larger eggs, larger sporangia, absence of strictly basal antheridia and presence of elongated forms of sporangia. Illustrations of the globular type of sporangia, which are the first to appear in clean and vigorous cultures are given in figures 1 and 2. They are of the same appearance as those of *P. cymosa.* The papilla is usually formed at the tip when growth is active, but if there is a rest it is as apt to be formed at any other point (figs. 2, 7, 10). Intermediate and elongated forms are shown in figs. 4 to 10. As in *P. cymosa* the internal pressure is dissipated before the last spores emerge and it is often many minutes before all find the exit. As shown in the figures, the papilla may be quite abrupt or may gradually taper into the body of the sporangium.

The oogonia are often closely associated with the sporangia (figs. 2, 11 and 12), but the more common arrangement is a terminal oogonium on a rather short lateral branch as shown in fig. 13, with a single stalked antheridium arising from immediately below it. The antheridial branch almost invariably carries but a single antheridium, which is short, thick and densely filled with protoplasm. The antheridial tube is quite conspicuous and its behavior is such that there is scarcely any doubt that fertilization takes place. The protoplasm of the antheridium passes into the tube and soon after no protoplasm or tube can be seen, indicating the discharge of the former and collapse of the very thin-walled tube. The tubes are distinctly shown in figs. 11, 12 and 15.

Oogonia with two eggs are not very rare. One of these with two antheridia is shown in fig. 14. Oogonia with four eggs were seen twice. One of these, of anomalous shape, is shown in fig. 16. The occurrence of more than one egg in the oogonium of *P.*

cymosa is quite rare. Humphrey saw two eggs only once and my cultures of that species have not produced any such oogonia. De Bary says that as many as three eggs may occur in *P. cymosa* but their appearance is evidently of great rarity.

In order to judge of the significance of the peculiar behavior of the spores in *Achlya paradoxa* it will be useful to review the variations in behavior in sexual reproduction in the Saprolegniaceae as recorded in the literature.

In the case of *Achlya* a departure from or modification of the usual grouping of the spores at the sporangium tip has been recorded in a few instances. In the first place it must be remembered that the spores in this genus are not perfectly quiescent during and immediately after emergence. A slight amoeboid motion is observable at all times from their initial formation to the appearance of the encysting membrane. Added to this is a certain feeble jerking and rotation due to the presence of cilia, that has been recorded by several observers since Cornu[8] first described it in 1872. On page 11 of his monograph Cornu says that these cilia have just enough agility to cause the escape of the spores from the sporangium, thus implying that they are the cause of the escape, a point that has been considerably discussed and which I shall take up at another time. The presence of cilia on the emerging spores of *Achlya* is strongly asserted by Hartog[9] who also predicts that they will be found in all species of *Achlya* and *Aphanomyces*.[10]

He also says in the first of these papers that the spores of *Achlya* after forming a ball revolve on their long axils for a short time before the cyst is formed, and that sometimes a few spores will detach themselves and swim away a short distance. In the second paper he says that "When the sporange is discharged near the margin of the hanging drop, or in a thin layer of water on a slide, we constantly see single spores escape from the mass, swim away, and encyst apart." This important observation has been frequently overlooked by subsequent workers, but I can confirm it

[8] Monographie des Saprolegniées. Ann. Sci. Nat. V. **15**: 5. 1872.
[9] Quart. Jour. Micr. Sci. **35**: 427. 1887.
[10] Ann. Botany **2**: 201. 1888.

positively for *Achlya caroliniana.* In this case if the sporangium is put on the slide in a very thin layer of water the spores will swim slowly apart on emerging and scatter themselves over a limited area near the mouth of the sporangium. By addition of iodine solution the cilia were clearly seen. In the case of *Achlya De Baryana*[11] I have recorded the occasional breaking up of the spore mass into scattered groups, but I have not seen any swimming motion in that species. Humphrey in his monograph also demonstrated the presence of cilia on the escaping spores of *Achlya americana.* It will be noted, however, that in none of these cases do any of the spores swim away regularly and under ordinary circumstances. In this respect *Achlya paradoxa* is unique.

In case of bacterial contamination, or foulness from any cause, or where the parts are put in liquid nutrient media, there is strong tendency for the spores to be retained in the sporangium, or if discharged for them to sprout at once without a second swimming stage. There has arisen a loose way of speaking of all sporangia when the spores are retained, or even in part retained, as "Dictyosporangia" a term that should be used, only when spores emerge through the wall of the sporangium and escape for (what is homologous with) the second swimming stage. As one might expect, there is variation in *Dictyuchus* itself in this respect, the spores frequently sprouting by the *Aplanes* method (see below). Variations in the discharge and behavior of the spores are recorded in the following cases:

Achlya aplanes Maurizio: Flora **79**: 109. 1894. The behavior of the spores in this case is very peculiar. There is no swimming stage, the spores on emerging sprouting into tubes. Frequently they do not emerge at all, but remain in the sporangium and sprout there.

Achlya caroliniana Coker: Bot. Gaz. **50**: 381. 1910. The spores may be retained and sprout as in *Aplanes,* or under certain circumstances may emerge in a motile condition.

Later observation by me shows that under certain conditions as an egg yolk in 1 per cent. KN_2PO_4 the spores may not stick to the sporangium mouth, but fall to the bottom in open order.

11 MYCOLOGIA 4: 319. 1912.

Achlya De Baryana Humphrey (*Achlya polyandra* De Bary): Coker, Mycologia 4: 319. 1912. Figs. 7 and 8, of plate 78, show reduced sporangia with spores in a single row, the spores emerging exactly as in *Dictyuchus*. They also frequently sprout as in *Aplanes*.

Achlya glomerata Coker: Mycologia 4: 325. 1912. In fig. 7, plate 79, is shown a sporangium with the spores sprouting as in *Aplanes*.

Achlya polyandra Hildebrand: Ward, Quart. Jour. Micr. Sci., **23**: 272. 1883. In plate 22, fig. 8, is shown a sporangium with the spores emerging just as in *Dictyuchus*. The retention of the spores in this case he was able to bring about by poor aeration, i. e., placing the culture in on air tight chamber.

Achlya prolifera (Nees) De Bary: Bot. Zeit. **10**: 473. 1852. In plate 7, fig. 28, is shown the sprouting of the spores at the mouth of the sporangium, the second swimming stage omitted. In all the seven species of *Achlya* that I have studied the second swimming stage may be easily suppressed.

Achlya racemosa Hildebrand: Pringsheim, Jahrb. für Wiss. Bot. 9: 191. 1873. In plate 22, figs. 1, 2 and 3, are shown sporangia emptying exactly as in *Dictyuchus*. Under the name of *Achlya lignicola,* which is now regarded as a depauperate condition of *A. racemosa,* Hildebrand figures a sporangium with many of the spores remaining undischarged (Jahrb. für Wiss. Bot. **6**: 249, plate 16, fig. 2. 1867).

Aphanomyces stellatus De Bary: Sorokin, Ann. Sci. Nat. VI. **3**: 46. 1876. In plate 7, figs. 10 and 18, are shown sporangia discharging their spores in the exact manner of *Dictyuchus*. He also shows sprouting at the mouth of the sporangium, and sporangia with spores in more than one row. See also Humphrey (Saprolegniaceae of the U. S., p. 79) for omission of second swimming stage.

Aplanes androgynus (Archer) Humphrey (=*Aplanes Braunii* De Bary): Reinsch, Jahrb. für Wiss. Bot. **11**: 283. 1877.

Under the name of *Achlya Braunii,* Reinsch states positively

that sporangia occur which show cell nets after the escape of the spores. He also says that in most cases after the emergence of the spores the cell nets are not visible, indicating that they disappear soon. His implication throughout is that the spores always escape as in *Dictyuchus,* and one of his figures (fig. 5, plate 14) clearly shows this method. However, in fig. 2 he shows two sporangia attached to an oogonium which are empty and show distinct openings for the discharge of the spores. In fact Reinsch did not observe at all the "*Aplanes* type" of spore germination as De Bary later described it (Bot. Zeit. **46**: 651. 1888). When we remember that De Bary speaks of the sporangia as of great rarity, it seems to me that we are entirely unjustified in asserting that the spores of *Aplanes* have no swimming stage. All of Reinsch's testimony is the other way, and as Fischer says (Kryptogamen Flora von Deutschland, etc., p. 367. 1892) there can be no doubt that Reinsch's plant and De Bary's are the same. In his description of the genus Fischer admits that net sporangia (as in *Dictyuchus*) seem also to occur occasionally.

Apodachlya pirifera Zopf: Nova Acta Kel. Leop. Carol. Akad. der Naturforscher **52**: 313. 1888. The spores normally encyst at the mouth of the sporangium and then emerge for a swimming stage as in *Achlya.* However, they may, on occasion, swim away in emerging, or they may encyst in part in the sporangium.

Dictyuchus monosporus Leitgeb: Jahrb. für Wiss. Bot. **7**: 357. 1867–70. In plate 23, fig. 8, is shown a sporangium with spores sprouting after the manner of *Aplanes.* This variation I have many times seen in an undescribed species of *Dichtyuchus* that is common at Chapel Hill.

Leptomitus lacteus (Roth) Agardh: Humphrey (Saprolegniaceae of the United States, etc.), says on page 136: "While the zoospores ordinarily escape from the sporangia, they sometimes become encysted within them (Fig. 117). It is this fact, probably, which led Braun to state ('51)[12] that the spores of *Lepto-*

[12] This refers to A. Braun. Betrachtungen über die Erscheinung der Vorjungung in der Natur. Leipzig, 1851. Also translated by Henfrey, Ray Society, London, 1853.

mitus are arranged in a row in the spore cases, and that 'no active gonidia seem to occur.'"

Monoblepharis macranda Woronin: Memoirs de l'Acad. Imp. des Sciences de St. Petersbourg. Cl. Phys. Natl. 8th series **16**: 1. 1904. In this species some or all of the spores may be retained in the sporangium and sprout there. Normally the zoospores on emerging show amoeboid movements.

Saprolegnia asterophora De Bary: Jahrb. für Wiss. Bot. **2**: 169. 1860. In plate 20, fig. 25, is shown a partly emptied sporangium, the remaining spores sprouting into tubes.

Saprolegnia ferax (Gruith.) Thuret: Ann. Sci. Nat. III. **14**: 214. 1850. In plate 22, fig. 8, Thuret shows an unopened sporangium with the spores sprouting in position. This is a good example of the *Aplanes* method.

In the case of a parasite on fish, that he considers *Saprolegnia ferax,* Smith gives a figure showing spores sprouting inside the sporangium at one end while others are swimming out at the other. Such a combination is probably fanciful (Grevillea **6**: 152. 1878. The same in Gardener's Chronicle, 4th of May, 1878).

In this same species Pringsheim (Jahrb. für Wiss. Bot. **9**: 191. 1874) gives an interesting case (fig. 12, plate 21) of the contents of an egg turning immediately into a sporangium, the spores being retained and sprouting in position. In figs. 1a, b, c, plate 20, he shows spores that had been retained in a partly discharged sporangium. These had sprouted in position to short tubes which became sporangia and discharged small spores.[13]

Saprolegnia monoica Pringsheim: Huxley, Quart. Jour. Micr. Sci. **22**: 311. 1882. He describes the regular occurrence towards the end of active growth of sporangia of the *Aplanes* type. He calls them, improperly, "dictiosporangia." In this plant, which was a parasite on salmon, it is noteworthy that Huxley found no motion in the spores but only a passive drifting about when discharged. In a similar (probably the same) plant, found as a parasite on fish, Anger (Ann. Sci. Nat. III. **2**: 5. 1844)

[13] The assertion by Gerard (Proc. Soc. Nat. Hist. Poughkeepsie, December 18, 1878, p. 25) of the occasional retention of the spores in *Saprolegnia ferax* is probably not based on any original observation.

gives a figure (fig. 11, plate 1) showing a few spores left in the sporangium and sprouting there into long tubes. In this parasite he records the spores as swimming on leaving the sporangium, not floating away as in Huxley's plant.

Saprolegnia torulosa De Bary: Lechmere, New Phytologist **9**: 305. 1910. In fig. 33, plate 2, is shown a sporangium with spores sprouting after the manner of *Aplanes*. Another example is shown in the same journal **10**: 167. 1911, fig. 2, on page 175. In his first paper he shows that the second swimming stage may be suppressed. De Bary in Vergleichende Morphologie and Biologie der Pilse, Leipzig, 1884, says (page 117) that the second swimming stage may be omitted in any species of *Saprolegnia*.

Saprolegnia sp.?: Pringsheim, Jahrb. für Wiss. Bot. **2**: 205. 1860. In plate 22, fig. 9, is shown a sporangium emptying exactly as in *Dictyuchus*. It is attached to a hypha which also bears a sporangium of the normal *Saprolegnia* type.

In both *Saprolegnia* and *Achlya* it frequently happens that the discharge of the spores is only partial, a few, or even a good many spores being left in the sporangium. These retained spores may emerge from their cysts, as normally, for a second swimming stage, moving about within the sporangium until they find their way out by its mouth. This is shown by Hildebrand for his *Achlya polyandra* (not *A. polyandra* De Bary) (Jahrb. für Wiss. Bot. **6**: 249. 1867, plate 16, fig. 2) and by Lechmere for *Saprolegnia torulosa* (?) (New Phytologist **9**: 305, plates 1 and 2. 1910, figs. 22, 23, 30, 31. Also in vol. 10, fig. 2, page 175). Lechmere erroniously calls this the *Dictyuchus* type of asexual reproduction. It is doubtful if the species of *Saprolegnia* (a parasite on fish) studied by him in his first paper is *Saprolegnia torulosa*. It is more apt to be the one that Huxley studied (Quart. Jour. Micr. Sci. **22**: 311. 1882) and supposed to be *S. monoica*.

Another peculiar and rare variation in the behavior of the sporangial contents is described and figured by Horn (Ann. Myc. **2**: 207. 1904) for *Achlya polyandra* De Bary (*A. De Baryana* Humphrey). At a temperature of 31° to 32° Celsius, sporangia were formed which emptied large masses of protoplasm

through several openings. These masses, then, by direct division formed spores, some of usual size (10 μ), some larger (up to 40 μ in diameter). If now brought to room temperature these small spores escaped from their cysts and swam. The larger ones germinated directly. He also mentions the occasional appearance of double spores from normal sporangia. The discharge of large and irregular masses of protoplasm from the sporangia had been figured by Leitgeb as long ago as 1869, for *Saprolegnia monoica* (Jahrb. für Wiss. Bot. 7: 357. 1869–70). In plate 24, fig. 5 he shows several such masses, some with cilia at different points, also several double zoospores. In a species of *Achlya* from Chapel Hill,[14] I have observed several times the emptying of the entire protoplasm from a sporangium at the tip, the mass falling at once to the bottom as a long contorted rope (see above, p. 291). This is still further and conclusive evidence that the spores are discharged by internal pressure and not through their own motion.

It will, of course, be understood that the variations reviewed above are in no sense fortuitous or accidental. They are the results of environmental conditions and many of them may now be induced at will by the investigator. A discussion of my own and other observations in regard to environmental influences on reproduction in this group will be reserved for another place.

In closing this short review of certain variations in the details of sexual reproduction in the group, I feel it necessary to give a word of caution against the attitude adopted by Lechmere in his two papers in the New Phytologist, both of which are referred to above. In the summary of his first paper he says that "As the result of keeping a species of *Saprolegnia* under observation for a period of five months it has been found possible to obtain on the same mycelium the methods of asexual reproduction which are characteristic of six different genera." If this claim is examined it will be seen that outside of its own genus (*Saprolegnia*) the species he describes cannot with accuracy be said to show the methods of a sexual reproduction of any other genera except *Aplanes* and *Leptolegnia,* and even in these cases only in certain

[14] A probable hybrid. See Journal Elisha Mitchell Scientific Society 30: 63. 1914.

details, not in all. The sporangial variations cited do not look like the sporangia of the genera in question and neither do the spores within them; and no one familiar with these genera would be misled into placing them there unless one's attention be focused on the wording of keys rather than on the plants themselves. Such variations as these do not create doubt, as Lechmere implies, on the validity of the presently accepted classification of the Saprolegniaceae. The occasional appearance of a soft-shelled egg in a hen's nest does not shake our faith in the reality of the distinction between a hen and a lizard.

Unless it be *Achlya paradoxa,* I know of no species whose genus could be in doubt after an adequate study of its asexual reproduction alone.

UNIVERSITY OF NORTH CAROLINA,
CHAPEL HILL, N. C.

Explanation of Plates CXLVI–CXLVIII

All drawings were made with the aid of the camera lucida.

Plate CXLVI

Achlya paradoxa sp. nov.

1. A group of empty sporangia of normal appearance. × 335.

2. A group of sporangia showing both lateral and internal proliferation. × 335.

3. Another example of the above. × 335.

4. A sporangium with spores killed during exit, showing the cilia. × 335.

5. An oögonium with base intercalated in a hypha. The projection below is not usual. An antheridium was present, but is not shown. × 335.

6, 7 and 8. Typical oögonia with antheridia. × 335.

9 and 10. Chlamydospores. × 335.

Plate CXLVII

Pythiopsis cymosa De Bary

1. Oögonium with a typical sub-basal antheridium. × 720.

2. Ditto, with an additional lateral antheridium. × 720.

3. Ditto, with two sub-basal antheridia. × 720.

4, 5, 6 and 7. Oögonia of various forms with antheridia of various origin. × 720.

8. An abnormal double oögonium, apparently without an antheridium. × 720.

9. Sporangia of typical shapes. × 447.

10. Sporangia about one minute before discharge showing the spores in the compression stage. × 447.

Chlamydospores; one having discharged spores by a basal papilla. × 447.

12. Spores, killed while swimming; one with four cilia and double size. × 720.

Plate CXLVIII

Pythiopsis Humphreyana sp. nov.

1. Sporangia of the globular form. × 335.

2. Two sporangia with an oögonium and antheridium. × 335.

3, 4, 5, 6, 7, 8, 9 and 10. Sporangia of various forms. Nos. 3 and 4 × 185; others × 125.

11. A sporangium, surrounded with several oögonia. × 185.

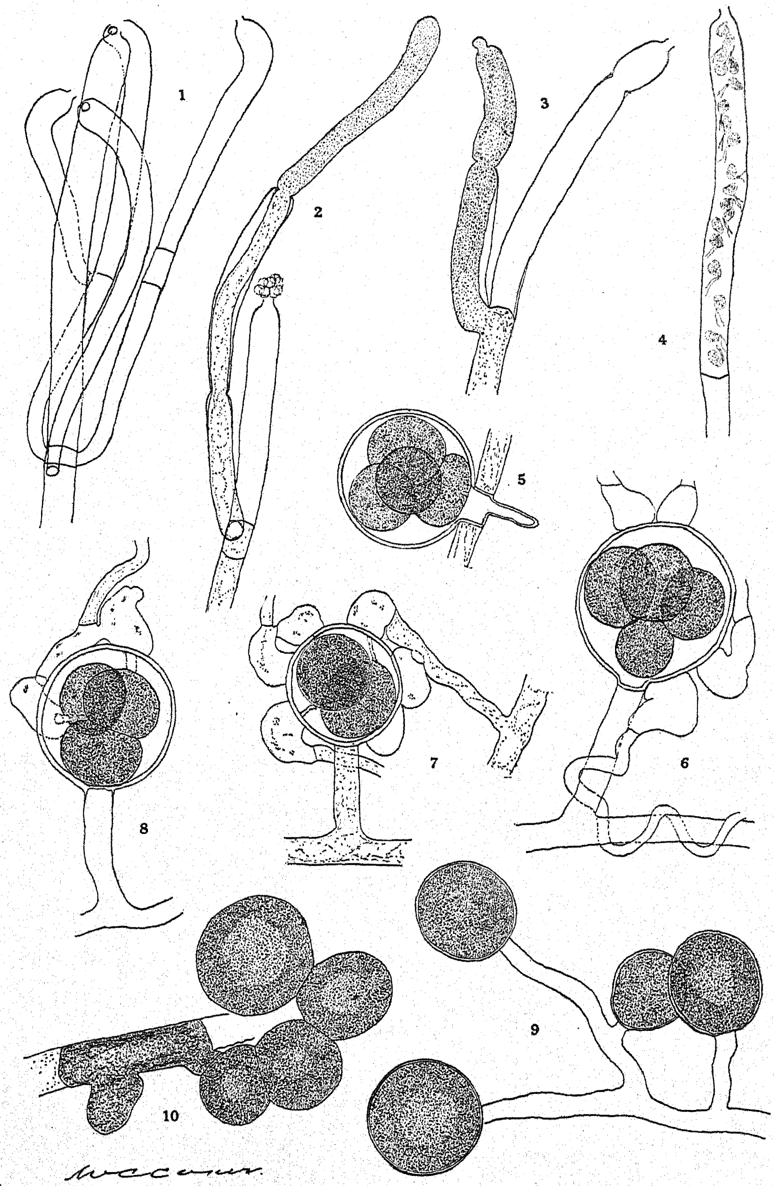
12. Two sporangia, with oögonia in close proximity. × 185.

13. A young oögonium with antheridium. × 335.

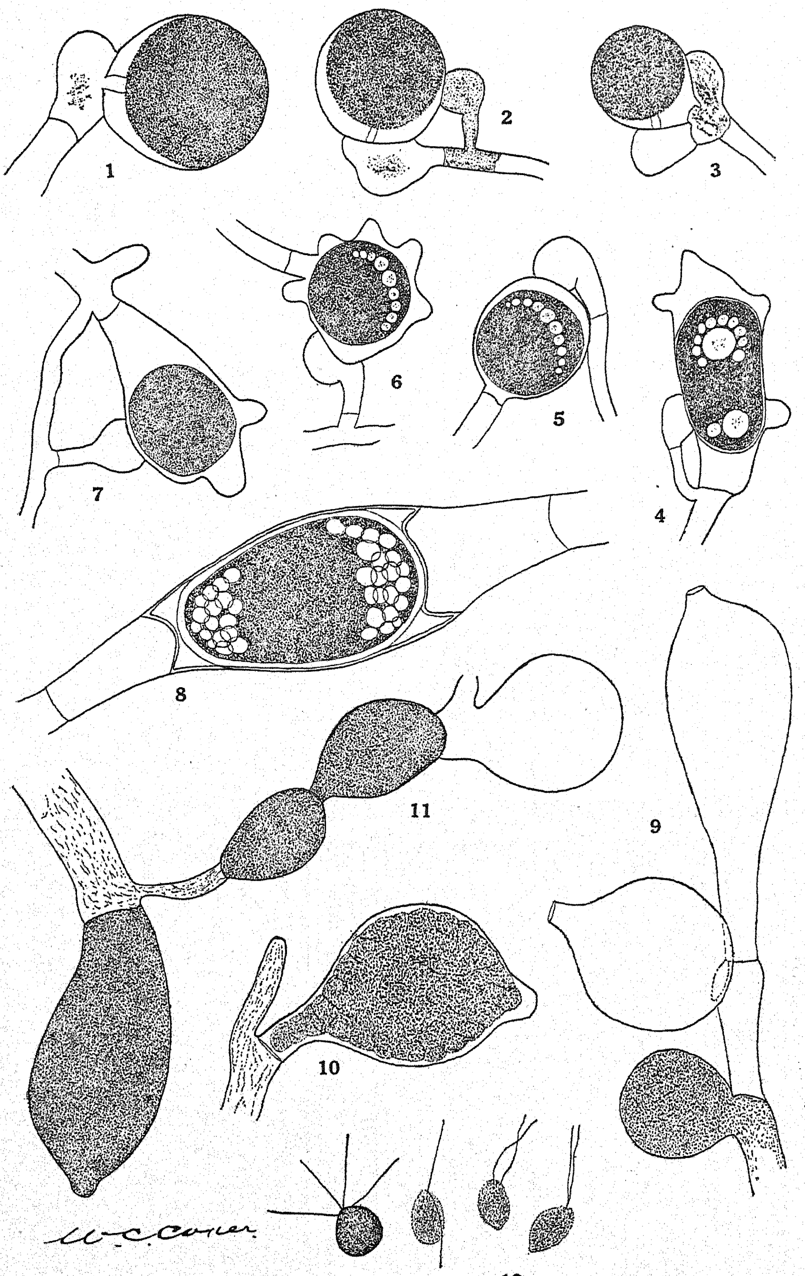
14. An oögonium with two eggs and two antheridia, one of which is diclinous. × 335.

15. Another oögonium with a diclinous antheridium, showing plainly the antheridial tube. × 335.

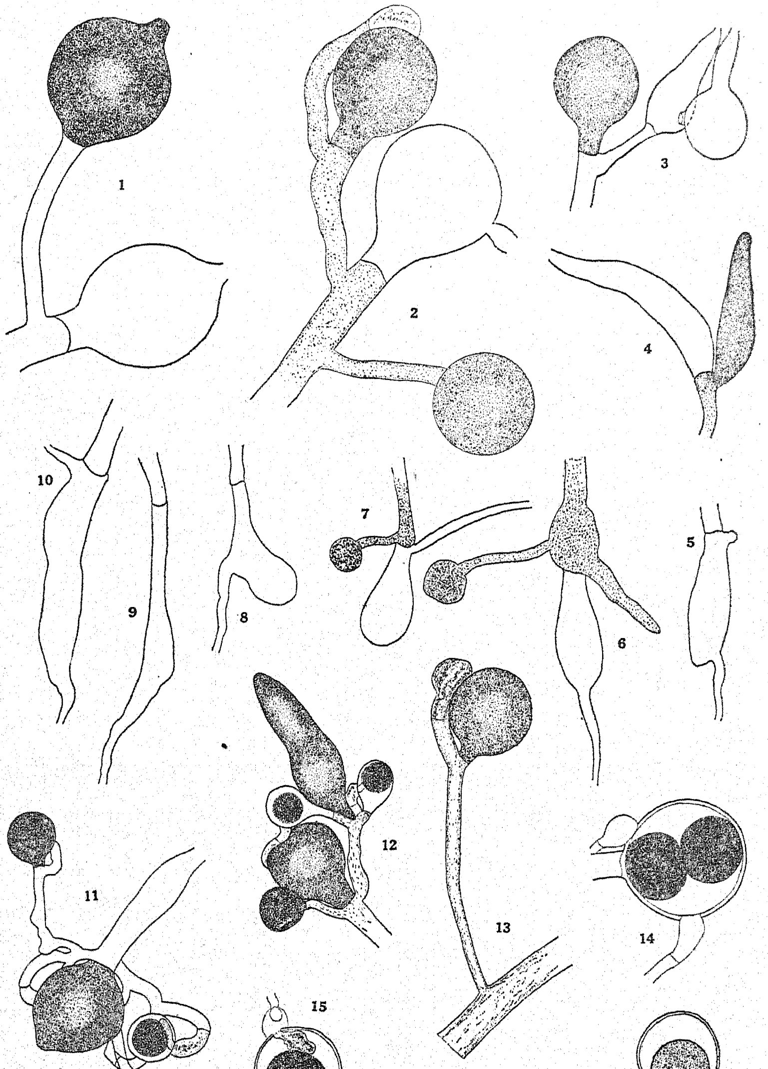
16. An abnormal oögonium with four eggs. × 335.



ACHLYA PARADOXA COKER



PYTHIOPSIS CYMOSA DE BARY



PYTHIOPSIS HUMPHREYANA COKER

NEWS AND NOTES

Mr. S. M. Zeller, formerly of the botanical department of the University of Washington at Seattle, now holds a research fellowship at the Missouri Botanical Garden in St. Louis.

Mr. Guy West Wilson, formerly forest pathologist at New Brunswick, New Jersey, has been appointed assistant professor of mycology and plant pathology in the State University of Iowa at Iowa City.

Dr. F. D. Kern, professor of botany at State College, Pennsylvania, visited the Garden on September 5–8 to examine the herbarium, library, and collections of living plants under glass.

Dr. C. J. Humphrey, forest pathologist at the Products Laboratory, Madison, Wisconsin, visited the Garden on October 23 to consult the collection of polypores. He intends to spend part of December in Cuba collecting fungi.

Professor Guy W. Wilson calls attention to an error in his paper on *Phytophthora* published in MYCOLOGIA last March. On pages 73 and 80, *Phleophythora* is incorrectly used for *Phloeophthora*. Klebahn's paper on "Eine Neue Pilzkrankheit" (Cent. Bakt. II. **15**: 335. 1905) should also be added to the bibliography.

Dr. Howard J. Banker, who has been professor of botany in De Pauw University for the past ten years, recently resigned his position to become a special investigator with the Eugenics Record Office at Cold Spring Harbor, New York. He will enter upon his new duties on October 1. Dr. Donald W. Davis succeeds Dr. Banker at De Pauw.

Mr. J. R. Johnston, who has made extensive investigations of cocoanut and sugar cane diseases in tropical America, spent Au-

gust 10–12 at the Garden consulting the herbarium and library. He has resigned his position with the Porto Rico Sugar Growers' Association at Rio Piedras, Porto Rico, to accept the position of plant pathologist in the agricultural experiment station at Santiago de las Vegas, Cuba.

A manual entitled "Northern Polypores" has just been published by Dr. W. A. Murrill, which contains descriptions of all the pileate species found in North America east of the Rocky Mountains and north of North Carolina. Keys and notes accompany the descriptions. Similar manuals by Dr. Murrill entitled "Southern Polypores," "Western Polypores," "Tropical Polypores," and "American Boletes" are expected to appear within a short time.

Dr. Arthur Harmount Graves has resigned his position as assistant professor of botany in the Sheffield Scientific School of Yale University, and is at present engaged in research at the laboratory of Dr. V. H. Blackman, professor of plant physiology and pathology at the Royal College of Sciences, South Kensington, London, England. Dr. Graves has been a member of the faculty of Yale for the last twelve years. His present address is, Care of Brown, Shipley & Co., 123 Pall Mall, London, England.

Dr. W. A. Murrill visited Washington and parts of Virginia during the latter part of September and collected a number of fungi of interest. He found the two poisonous species *Venenarius phalloides* and *Clitocybe illudens* especially abundant, the latter growing in open fields as well as in woods, about old stumps and buried roots. All of the woodlands were found to be infected with the chestnut canker, which caused the death of many individual branches this season, but is expected to do the greatest damage in the next two or three years. As a large percentage of the timber about Washington is chestnut, the loss will be very considerable.

The Underwood Collection of Fungi, containing 17,000 specimens, was purchased by the New York Botanical Garden in July,

1914. In addition to valuable sets of published exsiccati, it contains a full representation of all the fungi collected by the late Lucien M. Underwood at Auburn, Alabama; Greencastle, Indiana; Syracuse, Kirkville, Jamesville, and Clyde, New York; West Goshen and Redding, Connecticut; and at many points in and about New York City. There are also miscellaneous specimens from many parts of North America, either collected by Dr. Underwood in his travels or sent in by collectors for determination. All groups of fungi are well represented in this collection and the specimens are well preserved. Many of them are valuable types.

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New names, and the final members of new combinations, are in **bold face type**